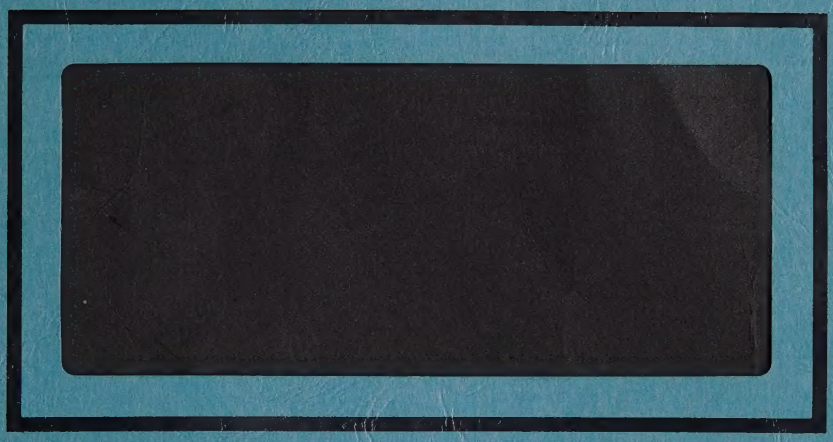

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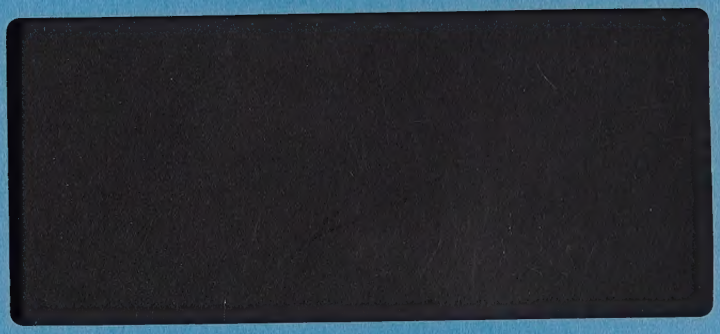

INSTRUCTION MANUAL

MODEL 7271

LIN-LOG / SWEEP GENERATOR

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IF YOUR INSTRUMENT DOES NOT OPERATE

PLEASE

1. Check operating procedure in manual for proper setup.

2. Check fuse and power supply voltages.

3. Call your Exact representative or factory. Instruments returned to the factory will be accepted only if they are sent freight prepaid, unless Exact or factory representative has authorized otherwise.

CLAIM FOR DAMAGED SHIPMENT

The instrument should be inspected as soon as received. If damage has occurred, a claim should be made with the carrier. The claim agent should receive a complete report of damage and a copy sent to Exact. After receiving this report, Exact will advise you of the dispostion of the instrument and arrange for its repair or replacement.

WARRANTY

Exact warrants its instruments to be free from defects in material and workmanship under normal use for a period of twelve months from the original date of shipment. Exact's obligation is limited to repair or replacement.

All repairs and replacements made under this warranty are f.o.b. Exact's factory or designated service depot unless otherwise authorized by Exact. This warranty is made on condition that prompt notice of defect is given to Exact, in writing, within the warranty period and that Exact shall have the sole right to determine whether in fact a defect exists.

This warranty does not apply to any instrument which has been repaired or altered by other than Exact's own service representative so as, in Exact's judgment, to adversely affect it, nor which has been subject to misuse, negligence or accident or which has been operated contrary to sound practice or operating instructions.

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SECTION I

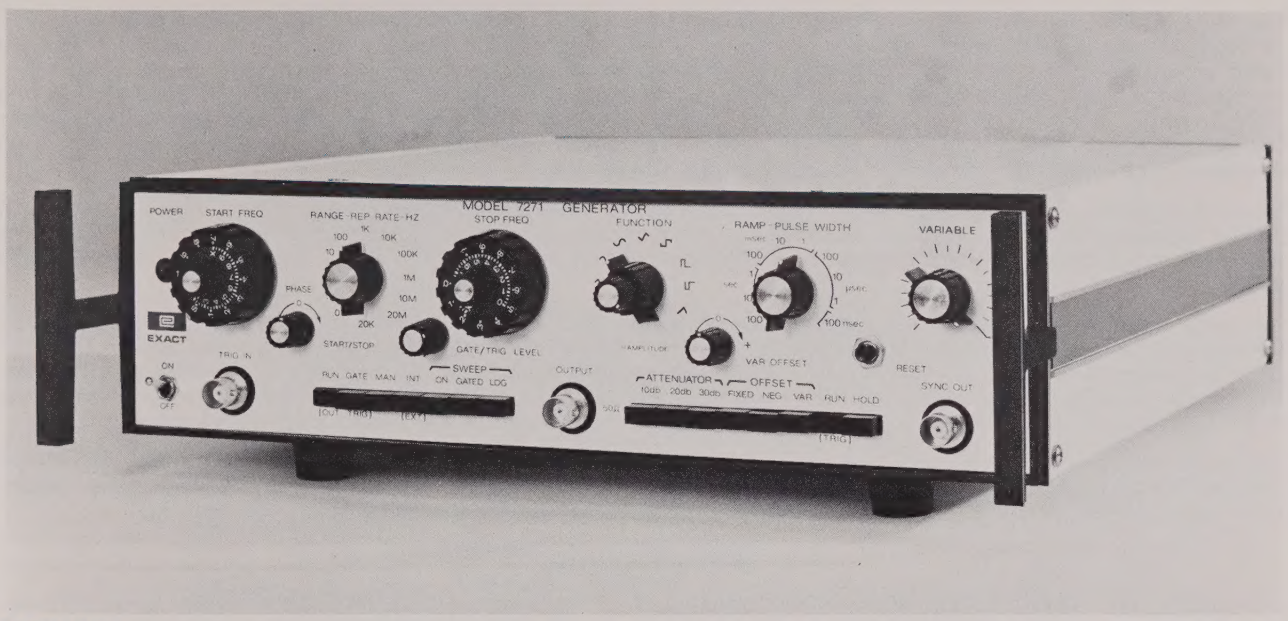
SPECIFICATIONS

AND

VERIFICATION OF SPECIFICATIONS PROCEDURE

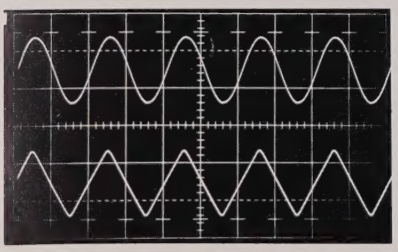
NOTES

MODEL 7271 LIN-LOG/SWEEP GENERATOR

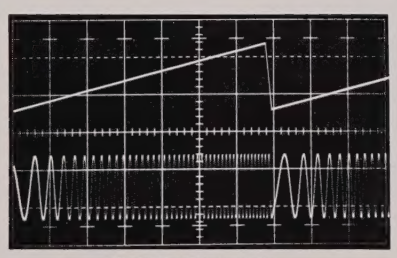


FEATURES

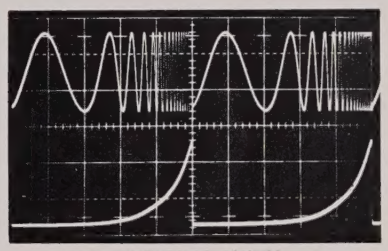
- 0.0001Hz to 20MHz
- SWEEP GENERATOR (1000:1 RANGE) LINEAR OR LOGARITHMIC
- PULSE GENERATOR VARIABLE WIDTH AND REPETITION RATES
- TONE BURST GENERATOR
- 80db ATTENUATION IN 10db STEPS AND 20 db VAR.
- AUDIO 20Hz - 20KHz
- V:f (VOLTAGE PROPORTIONAL TO FREQUENCY) OUTPUT
- GATED SWEEP
- VARIABLE PHASE, START/STOP
- KELVIN VARLEY DIVIDER FREQUENCY AND STOP FREQUENCY CONTROLS
- SEARCH MODE FOR MANUALLY SWEEPING OVER THREE DECADES
- FLOATING OUTPUT
- ±15V DC OFFSET
- 50Ω OUTPUT FOR PULSE APPLICATIONS
- 30V P-P OPEN CIRCUIT, 15V P-P INTO 50Ω
- RAMP HOLD ALLOWS SWEEP TO BE HELD AT BOTH ENDS



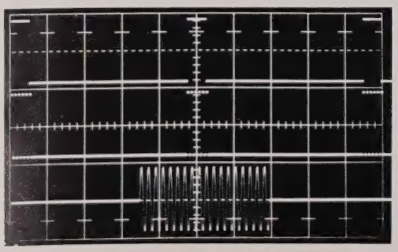
SINE SQUARE TRIANGLE



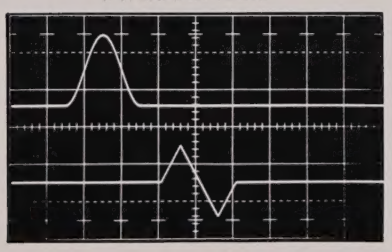
SWEEPING WITH INTERNAL RAMP



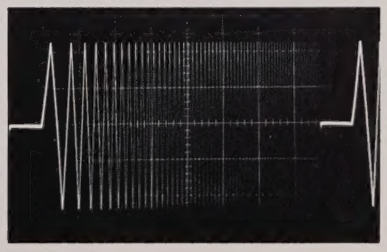
LOG SWEEPING WITH INTERNAL RAMP



PULSE AND BURST MODES



SINE² PULSE
SINGLE SHOT TRIANGLE



GATED SWEEP

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GENERAL

The Model 7271 contains two complete generators in one small unique package. The main generator is a VCF (Voltage Controlled Frequency) generator producing sine, square and triangle waveforms over an extremely broad frequency range of 0.0001Hz to 20MHz. The sweep generator is a ramp/pulse generator providing a linear ramp with a duration of 1000 seconds to 100nsec. It is used to internally sweep the main generator over a 1000:1 range, (three decades) or to internally gate the main generator for tone burst and single shot operation. The pulse function serves as a pulse generator whose repetition rate is governed by the main generator. A log converter allows internal logarithmic sweeping in the Model 7271.

A search mode is provided using the Kelvin-Varley divider frequency multiplier vernier so the main generator can also be manually swept over three decades. The pulse duration as well as repetition rate are variable. Both the main and ramp/pulse generator can be manually or externally triggered. The main generator can be externally gated.

The ramp output is available at the ramp output connecter and is also available at the main output amplifier. The main generator can be swept up or down in frequency by the ramp generator. All waveforms can be D-C offset by a front panel control or an external control voltage (VCO). A fixed D-C offset is also provided, either positive or negative. In the negative fixed offset position, the most positive excursion of any of the selected waveforms is ground. In positive fixed offset, the most negative excursion of the selected waveform is ground.

The Model 7271 is actually a combination SINE, SQUARE, TRIANGLE, VCF, LINEAR OR LOGARITHMIC SWEEP, TONE BURST, PULSE and independent RAMP GENERATOR in one versatile package. The trigger mode with variable phase and the ±sine output provides sine² pulses for transmission line testing.

SPECIFICATIONS

WAVEFORMS: Sine, Square, Triangle, Ramp, Pulse, Sync, ±Square, ±Sine, ±Triangle, ±Pulse, +Ramp

MODES OF OPERATION
Main generator: Run, Gate, Trigger, Pulse, Burst, Linear Sweep, Log Sweep, Gated Sweep
Ramp generator: Run, Trigger

RAMP HOLD: Ramp can be caught and held at its peak which allows the stop frequency to be measured in the sweep mode.

DYNAMIC FREQUENCY RANGE:
Main generator, 0.0001Hz to 20MHz
Ramp generator, 1000sec to 100nsec

FREQUENCY ACCURACY:
Main generator: ±(1% of setting plus 1% of frequency range) 0.01Hz to 1MHz; ±(2% of setting plus 2% of frequency range). .001 - .01 Hz and 1MHz - 20MHz.
Ramp generator: 1000sec to 100nsec in 10 calibrated steps. Accurate within ±5%. Uncalibrated, continuously variable between steps.

MAIN OUTPUT: 50Ω output impedance. All waveforms 30V p-p open circuit, 15V p-p into 50Ω with exception of ± fixed offset waveforms which are 15V peak open circuit, 7.5V peak into 50Ω. A full 80db of attenuation is provided in 10db steps with 20db continuously variable.

SINE FREQUENCY RESPONSE: 0.1db to 100KHz, 2 db to 20MHz.

SINE WAVE DISTORTION: <0.5% 0.001Hz to 100KHz (typically <0.2%). No harmonics <30db down 100KHz to 20MHz.

SQUARE WAVEFORM: Rise and fall <15nsec. Overshoot and ringing <5%.

SYMMETRY (time): ±(1% + 10nsec.)

TRIANGLE LINEARITY: 99% to 100KHz, 95% to 20MHz.

FREQUENCY STABILITY: 0.05% of setting for 10 min., 0.25% of setting for 24 hours.

AMPLITUDE STABILITY: 0.05% of max. p-p amplitude for 10 min., 0.25% of max. p-p amplitude for 24 hours.

MAIN GEN. TRIGGER INPUT:
Input: DC coupled, input impedance approx. 1K. Trigger signal requirements; manual or external voltage of approx. 100mv for turn on Trigger level adjustable. Approx. 100mv to 15V.

RAMP TRIG INPUT: External connection for external triggering ramp. TTL compatible.

SYNC INPUT: On rear panel. Allows Model 7271 to lock to an external frequency or clock. Requires 5V p-p to lock. External frequency must be within 1% of Model 7271 frequency for lock to occur.

VCF INPUT: (voltage controlled frequency) Approx. 5V input for 1000:1 (three decades) frequency control.

DC OFFSET: Variable ±7.5V into 50Ω, ±15V open circuit. Note: DC offset plus signal cannot exceed maximum voltage output or clipping will occur.

DC OFFSET INPUT: 1:1 inverting DC offset input allows external analog programming of DC offset. +1V input gives −1V DC offset in output. Step attenuator attenuates output signal and external DC offset equally.

V:f OUTPUT (voltage proportional to frequency): Output voltage directly related to frequency. Approx. 5mv to 5V for 1000:1 range.

SYNC OUTPUT:
Main generator: Square wave approx. 2V p-p open circuit. Approx. 100Ω output impedance.
Ramp generator: Square pulse approx. 2V peak open circuit. Approx. 100Ω output impedance. Coincident with start of ramp. Located on rear panel.

AUXILIARY RAMP OUTPUT: Typically 2V peak open circuit. 50Ω output impedance.

POWER REQUIREMENTS:
Input voltage - 115V AC ±10% or 220V ±10% (other voltages available).
Frequency —50 to 60Hz.
Power consumption approx. 100W

PHYSICAL CHARACTERISTICS:
12½" wide x 3½" high x 13½" deep
Top and bottom covers are easily removable, exposing all calibration and circuit board areas.

PRICE: (f.o.b. Hillsboro, Oregon)

NOTE: (unless otherwise stated) Specifications apply 10% to maximum output voltage, terminated into 50Ω and do not apply in the Search mode.
Specifications are valid at 25° C ±5°C after 1 hr. warm-up time. All stabilities are for constant line voltage and temperature.

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VERIFICATION OF SPECIFICATIONS

It is recommended that the instrument be operated with covers in place for a period of 1 hr. before verification of specifications.

The following test equipment or suitable equivalents of known accuracy are required for complete specification validation for the Model 7271 Waveform Generator.

Oscilloscope, DC to 90 MHz
Differential Input with 5mv/cm sensitivity
Tektronix 7704 with 7A13 Plug-in or equivalent
Counter-Timer, 11 MHz to 10,000 seconds
DANA 8010B or equivalent
DVM, .01% accuracy with 1,000 meg ohm floating input
DANA 4300 or equivalent
Harmonic Distortion Analyzer, less than .1% residual distortion
Hewlett-Packard 333 or equivalent
Spectrum Analyzer, 1 MHz to 300MHz
Nelson Ross PSA 311 in Tektronix 544 frame or equivalent.

Preset all the front panel controls as follows:

START FREQUENCY - 1.0
STOP FREQUENCY - .10
FUNCTION - square
AMPLITUDE - mid range
VAR. OFFSET - mid range
ATTENUATOR - All sections deactivated
RUN - activated
PHASE - mid range
RANGE - 1K
HOLD - deactivated
GATE - deactivated
INT. - deactivated
SWEEP ON - deactivated
SWEEP GATED - deactivated
SWEEP LOG - deactivated
GATE/TRIGGER LEVEL - mid range
RAMP-PULSE-WIDTH - 1 msec
VARIABLE - Cal.
RAMP RUN - deactivated
OFFSET FIXED - deactivated
OFFSET VAR. - deactivated
OFFSET NEG. - deactivated

FREQUENCY ACCURACY: To measure the frequency accurately all frequency measurements below 1 kilohertz are expressed in time and all above in freq. With the counter connected to main output:

Mult.	Range (Hz)	Actual Setting	Accuracy	Generator should be within
1.0	X .01	.01Hz	± (2% of setting + 2% of Range)	104 Sec. to 96 Sec.
.10	X .01	.001Hz	"	1282 " to 820 "
1.0	X .1	.1Hz	± (1% of setting + 1% of Range)	10.2 " to 9.8 "
.10	X .1	.01Hz	"	112 " to 90 "
1.0	X 1	1.0Hz	"	1.01 " to .99 "
.10	X 1	.10Hz	"	11.2 " to 9.00"
1.0	X 10	10Hz	"	.102 " to .098"
.10	X 10	1.0Hz	"	1.11 " to .890"
1.0	X 100	100Hz	"	10.2 ms to 9.80 ms
.10	X 100	10Hz	"	112 ms to 90.0 ms
1.0	X 1K	1KHz	"	1.02 ms to .980 ms
.10	X 1K	100Hz	"	11.2 ms to 9.00 ms
1.0	X 10K	10KHz	"	9.80 KHz to 10.2 KHz
.10	X 10K	1KHz	"	.890 KHz to 1.11 KHz
1.0	X 100K	100KHz	"	98.0 KHz to 102 KHz
.10	X 100K	10KHz	"	8.90 KHz to 11.1 KHz
1.0	X 1M	1.0MHz	"	.980 MHz to 1.02 MHz
.10	X 1M	100KHz	"	89.0 KHz to 111 KHz
1.0	X 10M	10MHz	± (2% of Range + 2% of setting)	9.60 MHz to 10.4 MHz
.10	X 10M	1MHz	"	.780 MHz to 1.22 MHz
1.0	X 20M	20MHz	± (5% of Range + 5% of setting)	18.0 MHz to 22.0 MHz
.10	X 20M	2MHz	"	3.10 MHz to .900 MHz

SINE DISTORTION: Return the Function Selector to Sine Wave and also check to see that generator frequency is set for 1 kilohertz. Amplitude Control should be set for mid range.

1. Connect Distortion Analyzer to the Output Connector terminated into 50Ω. Measure the sine distortion of less than .5% typically .2%.

2. Set the Range to 100K. Measure Sine distortion of less than .5%.

3. Set Range to 1MHz. Connect the Spectrum Analyzer to main output jack and measure the harmonic content. Observe no harmonics less than 30 db down.

4. Check Harmonic Content on 10MHz and 20MHz Range. Observe no harmonics less than 30 db down.

SINE FREQUENCY RESPONSE: Set the Range to 10K and connect the oscilloscope to the Output connector.

1. Observe sine wave amplitude.

2. Set Range to 100K. Observe sine amplitude drop less than .1 db.

3. Set Range to 10MHz. Observe sine amplitude drop less than 2 db.

SQUARE WAVEFORM: Set Function Switch to Square. Set Amplitude Control for an output voltage of 10V peak to peak or less into 50Ω. Any voltage greater than this value could yeild a rise time that is slower due to the slewing rate limitations.

1. Observe the rise and fall time to be less than or equal to 20 nanoseconds.

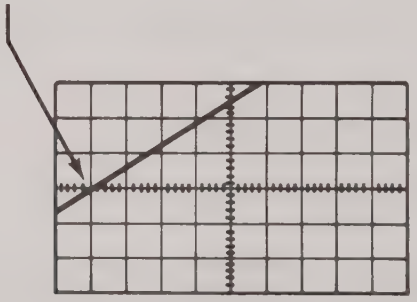
2. Observe that the overshoot and ringing are less than 5% of maximum peak to peak amplitude.

TRIANGLE LINEARITY: Set Range Switch to 1K. Set the Function Selector to Triangle. Monitor the Output Connector with the oscilloscope.

1. Adjust the oscilloscope to obtain 1/2 cycle of the triangular waveform across the full horizontal grid on the oscilloscope CRT.

2. Reset the Differential Plug-in to a sensitivity of 20 millivolts per centimeter.

3. Adjust the comparison voltage until the slope of the triangle waveform intersects the mid-scale horizontal grid line at the second major mark as shown below.



TRIANGLE LINEARITY: (Continued)

4. Record reference voltage using the DVM accurate to I millivolt.

5. Adjust the comparison voltage until slope of triangle intersects next major horizontal grid mark.

6. Record accurately the new reference voltage.

7. Repeat to obtain as many points as desired.

8. Calculate linearity and observe linearity is within specifications.

9. Beware of oscilloscope inadequacies above 10KHz.

FREQUENCY STABILITY: Connect Frequency Counter to main output terminated into 50Ω. Measure frequency accurately. Note the frequency reading. Wait 10 minutes. Measure frequency again and note that frequency change should be less than .05%. Wait 24 hrs. Measure frequency again and note reading remains within .25%.

AMPLITUDE STABILITY: Set amplitude control to maximum. Set DC Offset to Off. Function to Triangle. Connect output of generator to oscilloscope and measure the output, both positive and negative peaks with a 20 millivolt per centimeter sensitivity on the oscilloscope. Measure accurately and record the value of the positive and negative peaks that the triangle produced at the output. Wait 10 minutes and measure positive and negative peaks again and observe the amplitude changes less than 15 millivolts. Wait 24 hrs., measure the positive and negative peaks again and observe the amplitude change is less than 75 millivolts. Note that when measuring the amplitude using the peaks the maximum peak to peak value is the addition of the two peak values.

TIME SYMMETRY: Connect the counter timer to the Sync Output Connector on the front panel. Set the Range to 10K and set the Multiplier to 1.0. Set the Counter Timer to read time interval A to B and B to A. Observe the time symmetry error is less than 1%.

1. Set Range switch to 1K. Observe time symmetry error less than 1%.

2. Set Range to 100. Observe time symmetry error less than 1%.

3. Set Range to 10. Observe time symmetry error less than 1%.

4. Set Range to 1. Observe time symmetry error less than 1%.

RAMP FREQUENCY ACCURACY:

Deactivate the main generator Run button and activate the Ramp Run button.
Select Ramp waveform on the Function Selector.
Verify variable Ramp-Pulse Width control is in the Calibrated position.
Connect the counter timer to the Ramp Sync Output on the rear panel and set it to read time between the rising edge of the pulse and the falling edge of the pulse.

Ranges should read as follows:

Ramp-Pulse Width	Reading should be within
100 sec.	95 - 105 sec.
10 sec.	9.5 - 10.5 sec.
1 sec.	.95 - 1.05 sec.
100 msec.	95 - 105 msec.
10 msec.	9.5 - 10.5 msec.
1 msec.	.95 - 1.05 msec.
100 µsec.	95 - 105 µsec.
10 µsec.	9.5 - 10.5 µsec.
1 µsec.	.95 - 1.05 µsec.
100 nsec.	95 - 105 nsec.

SECTION 2

OPERATING INSTRUCTIONS

2.1.0 FRONT PANEL FAMILIARITY (Figure 2.1.1)

1. Power On/Off Switch - turns on input power to instrument.

2. Pilot Lamp - indicates input power is On.

3. Function selector - selects waveform to appear at Output connector.

4. Amplitude Control - Allows 20 db continuously variable voltage at Output conector.

5. D.C. Offset - Allows continuously variable D.C. level of waveforms at the Output connector when activated by Offset Variable pushbutton.

6. Sync Out - Provides square waveform for synchronizing other equipment to Sine Square Triangle or Pulse waveforms.

7. Offset Variable - Activates the Variable D.C. offset control.

8. Offset Fixed - Selects unipolar waveforms at the Output connector. Activating this control maintains the most negative excursion of the waveform at zero volts (within instrument tolerance) and allows continuously variable control of the amplitude. (For Sine Square Triangle only).

9. Offset Negative - When activated at the same time as Offset Fixed reverses the action so that the most positive excursion is at zero volts (within tolerance) (Note 8 and 9 above for Offset Variable deactivated).

10. Attenuator 10 db, 20 db, 30 db - Allows fixed step attenuation of waveforms appearing at the Output connector. Any combination of the three controls can be activated providing a maximum additive step attenuation of 60 db.

11. Output connector - Provides 50 ohm output impedance for waveforms selected by the function selector.

2.1.0 FRONT PANEL FAMILIARITY

12. Start Frequency - This control allows vernier setting of the start frequency or the generator frequency from which the generator can be swept to another frequency by providing an outer dial with steps of 10% of its range and an S position which places the generator in the search mode plus providing a smaller variable adjustment that cover the range between each of the fixed steps of the outer dial.

13. Range - Repetition Rate - Hertz - This control selects the operating frequency range of the sine, triangular and square waveforms and it also selects the operating range for the repetion rate of the pulse waveforms.

14. Stop Frequency - This control allows calibrated fixed step adjustment of the end frequency that the generator will operate during a frequency sweep. The outer dial provides calibrated fixed steps with a 10% of range step and an inner dial with a vernier or continuously variable adjustment for operating between fixed steps of the outer dial.

15. Ramp-Pulse Width - This control selects the operating range for controlling the duration of one ramp waveform or the duration one pulse.

16. Variable - This control provides a continuously variable adjustment of the ramp or pulse width over an operating range of 10 to 1.

17. Gate/Trig.Level - This continuously variable control allows selection of the voltage at which the trigger input circuitry will be activated providing gated or triggered mode of operation.

18. Run - This control when activated provides a free running waveform as selected by the function selector.

19. Gate - This control when activated provides an external means of controlling when the generator runs in a free running mode or stops.When both the run and the gate controls are deactivated then the generator will provide a single cycle of a waveform for each external or manual command signal that is applied.

20. Manual - This control provides a manual means of gating or triggering the generated waveform.

21. Phase - Allows a continuously variable gate or trigger starting point for the sine and triangular waveforms.

22. Trigger Input - Accepts the input signals necessary for gated or triggered mode of operation.

23. Internal - This control when activated utilizes the ramp generator portion of this instrument to internally gate or trigger the sine, square and triangular waveform generator.

24. Sweep - This control, when activated, allows the ramp generator to vary the frequency of the main triangular, square and sine waveform generator at the rate selected by the Ramp-Pulse Width controls.

2.1.0 FRONT PANEL FAMILIARITY (Figure 2.1.1)

25. Run - This control, when activated, provides a free running ramp waveform for use in the sweep mode of operation or for generation of the ramp output waveform. When this control is not activated the ramp or sweep waveforms can be triggered externally.

26. Sweep Gated - When activated at the same time as Sweep On provides output signals from the main output only during the sweep time. For each Ramp or triggered Ramp the main generator is automatically gated on for the duration of the ramp time.

27. Sweep Log - This control selects a sweep from the Start Frequency Dial to the Stop Frequency dial that varies logarithmically with time rather than linearly with time as does the normal ramp used for sweeping.

28. Hold - This control interrupts the ramp waveform at its peak value after the linear rise and will cause the ramp to remain there until "Hold" is released.

29. Reset - Will return ramp waveform to its starting level during a cycle or when in a Hold mode.

2.2.0 REAR PANEL FAMILIARITY (Figure 2.2.0)

1. Line Voltage Selector - Allows instrument operation at 117 or 220 volts AC.

2. Fuse Holder - Allows easy replacement in the event of fuse failure.

3. Line Cord - Accepts input power for the instrument.

4. Circuit Common Connection - Allows floating circuit common operation of instrument.

5. Chassis Ground Connection - Provides for grounding of circuit commons.

6. Sync Input Connector - Accepts an input signal for synchronizing generator frequency.

7. VCF Input Connector - Accepts wide band AC or DC input for analog programming of generator frequency.

8. V:F Output Connector - Provides a direct current voltage that is proportional to the generator frequency.

9. DC Offset Input Connector - Accepts external analog signal for programming DC Offset. The Input utilizes a 1 to 1 inverting relationship to the output.

10. Ramp Trigger Input Connector - Accepts input signals for triggering the ramp-pulse generator.

11. Ramp Sync Output Connector - Provides a pulse waveform coincident with the ramp waveform. Also provides a pulse waveform coincident with the pulse waveforms at the main output.

12. Ramp Output Connector - Provides an output connection for monitoring the ramp waveform.

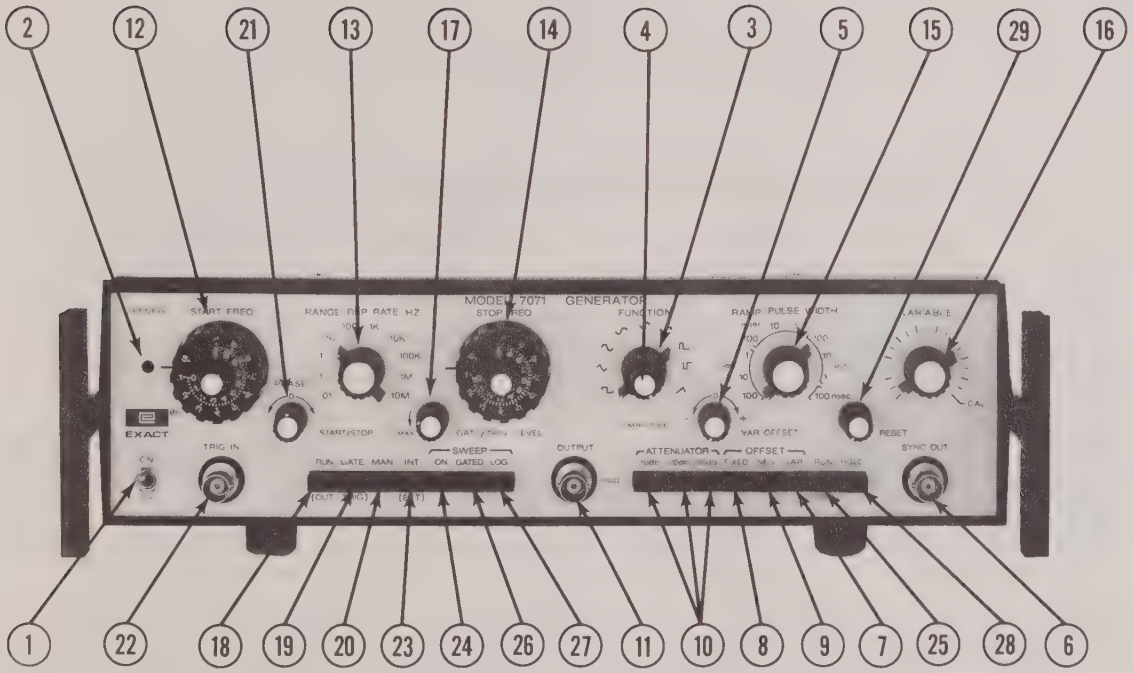


FIGURE 2.1.1 MODEL 7071 (E)
FRONT PANEL FAMILIARITY

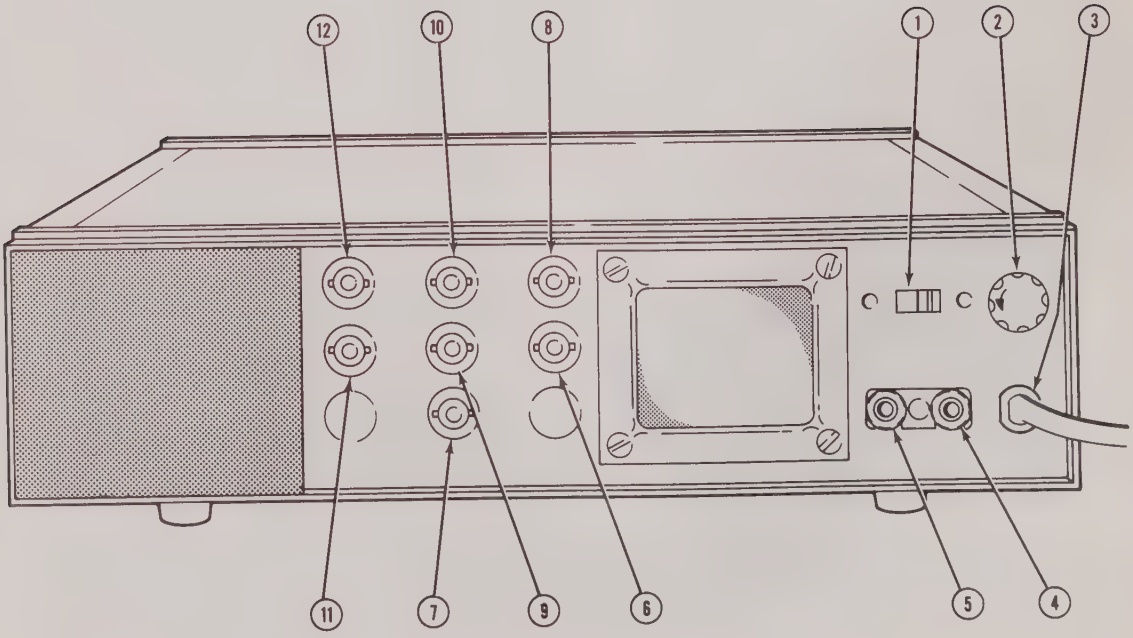


FIGURE 2.2.0 REAR PANEL FAMILIARITY ©Ⓔ

2.3.0 FIRST TIME OFERATION

NOTE: Before applyi ng power to the instrument the input power line switch must be in the proper position corresponding to the line voltage source which will be applied. The instrument is supplied with the proper fuse for 117 volt operation. If the unit is to be operated from 220 volts AC, place the line switch located on the rear panel to the 220 volt position and change the fuse as indicated by the fuse data silk screened on the rear panel.

NOTE: It is recommended that the rear panel chassis ground and circuit ground connections be connected together with the grounding strap provided unless it is necessary to float the instrument ground.

1. Plug the instrument into source of 117 volt 50 to 60 cycle AC power and turn on Power switch. Preset all front panel controls as follows:

START FREQUENCY	to 1.0
RANGE-REP.RATE	to 1K
STOP FREQUENCY	to 1.0
FUNCTION	to Triangle
RAMP PULSE WIDTH	to 100 microseconds
VARIABLE	to Cal.
AMPLITUDE	to maximum
PHASE	to mid range
RUN	activated or depressed
GATE	deactivated
MANUAL	deactivated
INTERNAL	deactivated
SWEEP ON	deactivated
SWEEP GATED	deactivated
SWEEP LOG	deactivated
GATE/TRIGGER LEVEL	maximum clockwise
ATTENUATOR	all three buttons deactivated
OFFSET	all three buttons deactivated
VARIABLE OFFSET	to mid range
RAMP RUN	deactivated or in trigger mode
HOLD	deactivated

2.3.0 FIRST TIME OPERATION

2. WAVEFORMS
   Connect generator outputs through 50Ω coaxial cable into 50Ω coaxial load and the vertical input of a suitable oscilloscope. The instrument should be providing a 1 kilohertz triangular waveform at approximately 15 volts peak to peak amplitude.
3. FUNCTION
   Switch the function selector through its Sine, Triangle and Square waveforms and observe the change in wave shape on the oscilloscope. Return the function selector to Sine wave.
4. AMPLITUDE
   Rotate the amplitude control through its range and note that there is a continuously variable control of 20db on the output amplitude of the generator. Return this amplitude control to mid range.
5. FIXED OFFSET
   Depress the fixed offset button and note that the waveform reduces in amplitude on the oscilloscope presentation and also note that its most negative excursion is 0 volts. Again rotate the amplitude control through its range and note that the most negative excursion under any condition is 0 volts for the selected waveform. Next depress the negative offset button while leaving the fixed offset button depressed. Note that the waveforms most positive excursion now is 0 volts and as you rotate the variable amplitude control this condition remains the same. Note that both fixed and negative offset buttons must be depressed to activate this mode. Deactivate both the fixed and negative offset buttons and return the variable amplitude control to mid range.
6. VARIABLE OFFSET
   Depress the variable offset button and rotate the DC offset control and note that the DC level of the waveform is now adjustable. Note maximum output signal levels must not be exceeded when utilizing both maximum amplitude and any amount of DC offset. Deactivate the variable offset button and return the amplitude control to mid range.
7. EXTERNAL OFFSET
   Using a low impedance variable voltage source apply a small voltage to the external offset input and note that for each positive volt of input there is a matching negative volt of output from the generator. Again noting that maximum output cannot exceed the maximum output level of the generator. Also note that for each negative volt of external offset applied there is a positive volt on the output thus verifying the relationship as a 1 to 1 inverting configuration. Remove the external supply and return the variable amplitude control to maximum clockwise.
8. ATTENUATOR
   Depress the 10db attenuator and note that the output amplitude reduces to approximately 1/3 of its original level. Deactivate the 10db attenuator and then depress the 20db attenuator and note that the output amplitude drops to approximately 1/10th its original level. Deactivate the 20db attenuator and depress the 30db attenuator and note that the output amplitude is reduced to approximately 1/30th the original amplitude. Leaving the 30db attenuator activated depress the 10db attenuator and note that the overall attenuation then adds to be 40db and so forth and so on until a maximum of 60db attenuation is attainable through the push button attenuation. Note also that these attenuators attenuate the DC offset in the same porportion as the output amplitude. Return all attenuator buttons to a deactivated state.

2.3.0 FIRST TIME OPERATION

9. EXTERNAL SYNC

Connect an external oscillator signal of approximately 5 volts peak to peak and approximately 1 kilohertz in frequency to the sync input connector. Rotate the Start Frequency Dial until the generator frequency is within 1% of the applied synchronizing frequency and the two generators should phase lock or synchronize together. This can be demonstrated by connecting the external synchronizing input of the oscilloscope to the external 1 kilohertz synchronizing source. As the waveform generator then becomes synchronized with the external source the waveform as it appears on the oscilloscope will not move and will be stable. Disconnect the external synchronizing signal and connect the oscilloscope external synchronizing input to the waveform generator sync output connector. Note that the oscilloscope again can be synchronized using the sync output connector from the generator.

10. MULTIPLIER AND RANGE DIALS

Return the Start Frequency Dial to a setting of 1.0. Note that the frequency then is 1.0 times the range setting of the 1K or 1 kilohertz. Turn the inner dial of the Start Frequency Dial to X and note that the generator frequency then has increased to 10% over the 1 kilohertz or 1.1 kilohertz. Return the inner dial to 0. Turn the outer dial to .9 and note then that the generator frequency is .9 times 1K or 900 hertz. Turn the inner dial up from 0 to X and note then that the frequency of the generator can be changed from 900 to 910, 920, 930 etc on up to 1000 hertz again. Return the inner dial to 0. Turn the outer dial through each of its steps and note that the generator frequency can be continuously varied from an overrange of 1.1 down to .1 times the range frequency setting or in other words from 100 hertz to 1 kilohertz. Rotate the outer dial to the position marked S and note then that the inner dial will cause the generator frequency to be varied from a maximum of the 10% overrange or 1.1 times 1 kilohertz down to 1/1000th of the 1 kilohertz or approximately 1 hertz. This is the search mode of operation providing the continuously variable 1000 to 1 range. Reset the inner dial to 0.

11. VCF

Connect an external DC voltage supply to the VCF input connector and note then that as the generator is at 1 hertz from the previous step above the generator frequency can be increased by applying the 0 to 5 volts to the VCF input connector. Rotate the Search Control to X and apply a negative 0 to 5 volts to the VCF input connector and note that the frequency can be reduced from 1.1 kilohertz down to the lower frequency of 1 hertz by applying negative 5 volts. Note that in no case should the generator frequency be increased beyond the 1.1 times the range setting nor should it be lowered below 1 hertz or 1/1000th of the range frequency setting. Return the Start Frequency Dial to 1.0.

2.3.0 FIRST TIME OPERATION

12. RAMP FUNCTIONS

Rotate the Function Selection to Ramp Waveform and depress the ramp Run button. Note then that on the output there is a 100 microsecond in length ramp waveform. Rotate the Ramp-Pulse Width selector to select the proper range of operating times as needed. Note also that the variable control provides continouously variable adjustment throughout 10 to 1 range of the ramp pulse width. Return Ramp-Pulse Width to 100 milliseconds, Variable to Cal, and deactivate Hold. Depress Hold and note that ramp waveform runs up to its peak value and will remain there. Depress the Reset button and note that the ramp returns to its starting point. Note: Ramp will remain at its starting point if the ramp generator is in the triggered mode (Run button released).

13. RUN, GATE, TRIGGER and TONE BURST

Return the Function Selector to positive going sine wave and deactivate the main generator Run button. Connect an external oscillator signal of approximately 5 volts peak to peak and 100 hertz in frequency to the Trigger Input connector. At the output then there should be a single cycle sine wave available for each cycle of the incomming 100 hertz waveform. Rotate the Gate/Trigger Level control and note that the trip voltage at which the generator cycle starts is variable through rotation of the Gate/Trigger Level control. Depress the Gate button and note then that the generator will run continuously as long as the externally applied oscillator voltage is greater than the Gate/Trigger level. Note then that this burst width can be controlled by the Gate/Trigger level. Note also that the generator always completes its last cycle of operation after the Gate signal has been removed. Remove the external oscillator signal from the trigger input connector and note that the generator can be manually controlled by depressing the Manual button. By depressing this button in the gate mode note that the generator will be gated continually while the button is depressed. Also note that in the trigger mode where both the Run and Gate buttons are deactivated that for each time the manual button is depressed a single cycle of output waveform is obtained. Deactivate all three Run, Gate and Manual buttons and depress the button marked Internal. Note, now that there is a positive going sine wave from the output controlled by the Gate-Trigger Level control and the Ramp-Pulse Width controls. In this mode the Ramp-Pulse generator is being used to internally operate the Sine, Square and Triangular generator. Note that in the trigger mode of operation for the main generator that for each ramp or pulse cycle there is one sine, square, triangle waveform generated. By depressing the Gate button on the main generator the burst of cycles then available can be controlled by rotating the Gate/Trigger Level control. Deactivate the internal button and activate the Run button for the main generator. Return the Ramp-Pulse Width control to 100 microseconds.

2.3.0 FIRST TIME OPERATION

14. PULSE GENERATION

Rotate the Function Selector to positive going pulse waveform. Note that the output waveform now obtained can be individually controlled in pulse width and repitition rate by the corresponding controls.

15. SWEEP

Return the Range-Rep Rate dial to 1K and return also the Ramp-Pulse Width control to 1 second, the Variable to Cal. Set the Start Frequency Dial to 0.1 and the Stop Frequency Dial should still be set to 1.0. Depress the Sweep button and the Ramp Run button. Note, now, that the output waveform is a sine wave that is starting at 100 hertz (the start frequency, times the Range-Rep rate) and sweeping up to a stop frequency of 1 kilohertz - that is, 1.0 times the Range-Rep rate of 1K. Note, now, that you have a continuously variable control of the frequency at which the sweep starts and a continuously variable control calibration for the frequency at which the sweep stops. Note, also, that as you set these dials that the start frequency may be set to a lower value than the stop frequency for starting at a low frequency and sweeping to a higher frequency. It is also possible to set the Start Frequency at a higher setting and the Stop Frequency at a lower setting and sweep from a higher to a lower frequency. Note that at the Ramp Sync Output connector there is a pulse coincident with the start of the Ramp that would provide synchronization of external equipment at the start of the sweep. Note, also, that if the Ramp-Run button is deactivated the ramp can be initiated by an external signal starting the sweep at the Ramp-Trigger Input connector. Note, also, that at the V to F Output Connector there is a voltage available that is directly proportional to generator frequency. Also available is the ramp output waveform that provides a continuous monitoring of the ramp waveform generated within the instrument. Depress the Sweep Gated button and notice that as the ramp Run button is still released the main generator locks out and provides no output until the ramp is triggered. When the ramp is triggered, the main generator automatically starts and continues until the ramp reaches its peak value and the main generator finishes its last cycle and the ramp will then reset to wait for another ramp trigger input. When the ramp Run is depressed the Gated off time is the ramp reset time in addition to the amount of time required for the main generator to complete its cycle.

16. LOG SWEEP

In the linear mode of operation, the start and stop dials vary the frequency linearly. Example:

On the 1K Range, .20 on the start dial = .2x Range setting in frequency = 200Hz
.30 on the start dial = 300Hz etc.

In the log mode of operation, the start and stop dials vary the frequency logarithmicaly. A chart is provided which will show the approximate setting for the start or stop dial to obtain the desired frequency.

LOG SWEEP CONTINUED

Example:

Set start frequency to 1.1 and Range 100K. Log pushbutton out (linear mode). Observe 110KHz ± 2%. Push Log Button in (log mode) and observe 110KHz ± 5%. Set start dial to .10 log button out (linear mode) and observe 10KHz ± 2%. As our chart indicates, 1.1 on the start dial corresponds to 1.1X range setting (100K) = 110KHz. Looking at .10 on the chart we see a corresponding frequency of .0019 X range (100K) which should be approximately 190Hz. Push log button in and observe approximately 190Hz.

In the linear mode, the frequency span of the Start Dial is 10:1 unless we switch to the search mode. In the search mode, the frequency span is 1000:1 or 3 decades. In the log mode, the frequency span is approximately 3 decades from 1.1 on the dial to .10 on the dial.

Example:

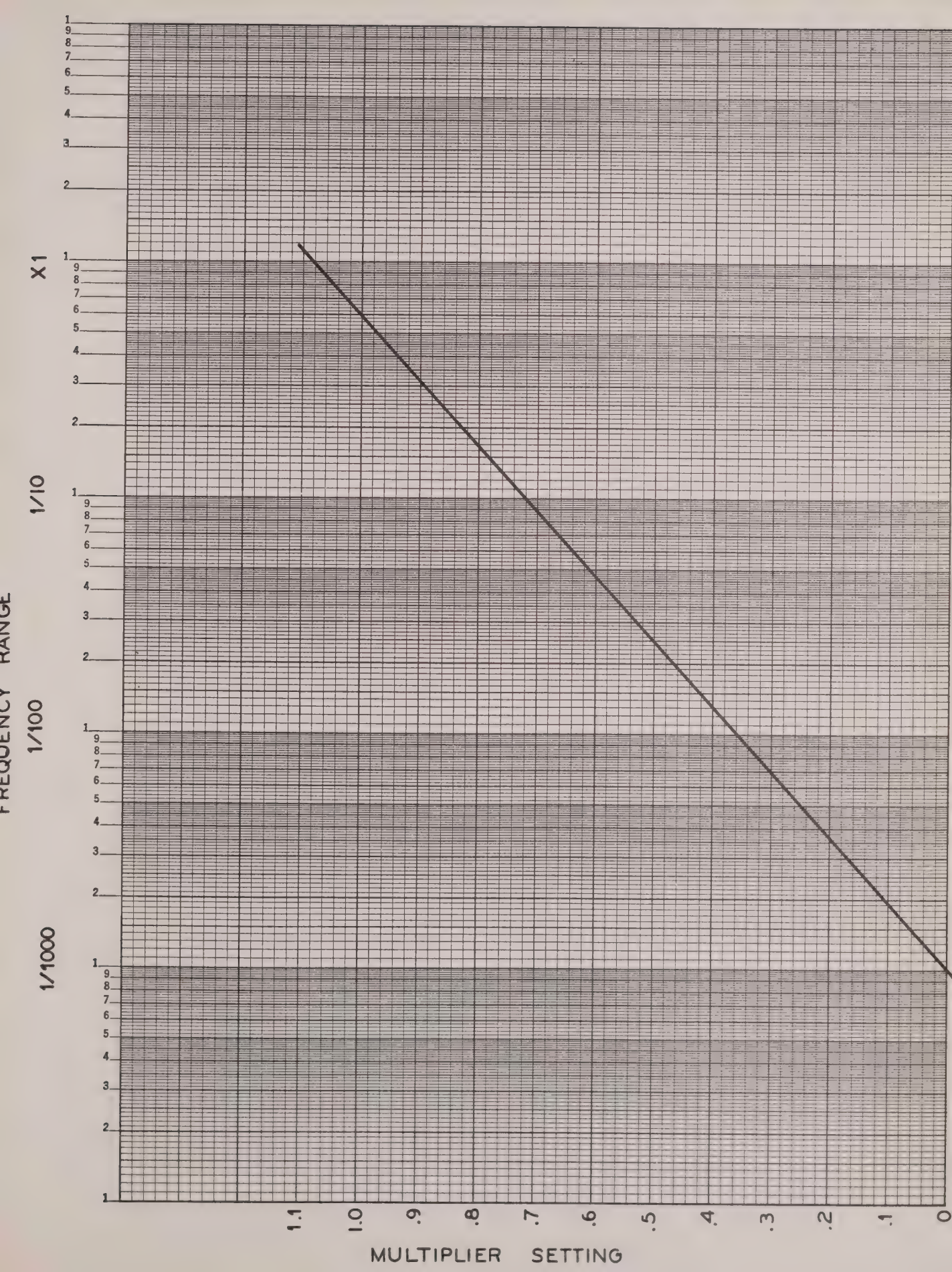
Range	Start Dial	Lin F	Log F
100K	1.0	100KHz	60KHz
	.50	50KHz	2.4KHz
	.20	20KHz	360Hz
	.10	10KHz	190Hz
	5.0 max ccw	100Hz	100Hz

The start and stop dials control the start and stop frequency point when sweeping internally. The generator will sweep up from the start frequency to the stop frequency or down from the start frequency to the stop frequency. In the linear sweep mode, the frequency changes linearly between the start and stop points and in log sweep the frequency changes logarithmicaly. In the linear mode, the start and stop frequency may be easily set as indicated on the start and stop dials but in the log mode of sweep, the start and stop points must be set using a frequency counter or the log chart provided for this purpose.

When sweeping externally, from the VCF Input, the start frequency may be set using the start dial. In the linear mode (log button out) the start frequency is as indicated. The frequency may be swept up or down linearly by applying a pos or neg voltage at the VCF Input. When the log pushbutton is in (log sweep) the frequency may be swept logarithmicaly up or down from the start frequency by applying a pos or neg voltage at the VCF Input.

NOTE:

In the log mode, the start frequency will have to be set using a counter or the log chart provided. The stop frequency has no effect when sweeping externally. The sweep width (stop frequency) is determined by the VCF Input voltage applied.


FREQUENCY RANGE
X1
1/10
1/100
1/1000
1
9
8
7
6
5
4
3
2
1.1
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
MULTIPLIER SETTING

SECTION 3

CIRCUIT DESCRIPTION

3.1.0 BLOCK DIAGRAM (Figure 3.1.1)

The basic generator loop utilized in this waveform generator consists of a pair of current sources alternately charging and discharging a timing capacitor. The triangular waveform generated in this timing capacitor is applied to a high input impedance triangle buffer amplifier which then applies the triangular signal to the bi-stable level detector. The output of this level detector is then fed back to alternately switch the current sources thus the loop is closed forming a free running generator. The level detector is used to switch the current sources at a predetermined point on the triangle thereby generating a constant amplitude triangle regardless of frequency of operation. Having generated a triangle of constant amplitude the frequency then is porportional to the timing capacitance and the current supplied to the capacitor from the constant current sources. Decade values of frequency are selected by decade selection of the timing capacitors and decade selection of the constant current sources. Variable frequency adjustment is accomplished by variable adjustment of the current sources through application of a DC voltage. For alternately charging and discharging the range capacitors one constant current source is a positive source and the other is a negative. In order that these can be externally controlled with a single DC voltage a pair level shifting amplifiers are supplied that convert a single input voltage to the voltages necessary to drive the positive and negative current sources. The positive and negative level shifting amplifiers are driven by the single VCF amplifier that can accept a signal either from the generator Multiplier dial or from an external DC voltage. The Multiplier dial receives its signal from a constant voltage amplifier called the Frequency supply.

This basic generator loop by nature provides a triangular waveform and a square waveform that can be processed and used as output signals to provide two waveforms. The triangular waveform can be processed through the sine converter to provide a sinusoidal waveform. The triangular waveform available at the output of the triangle buffer can be applied directly to the preamp through the function switching network. This then provides the triangular output waveform. The square waveform from the level detection network is applied directly to the square amplifier which then goes directly to the preamplifier. The square amplifier by nature can accept a DC signal from the function switching network to either activate or deactivate its operation. For sinusoidal operation the triangular waveform from the triangle buffer is supplied through the function switching network to the sine converter. The output of the sine converter is then fed to a sine amplifier which boosts the operating voltage level of the waveform. This waveform is then applied back through the function switching network to the preamplifier. The preamplifier utilized in this generator is used to boost the operating signal levels generated by the basic generator loop to something suitable for processing in the power amplifier. The preamp is also used to provide the offset functions which decrease the amplitude of the generated waveform to one-half and offset it to a value that maintains one peak at 0 volts. The output of this preamp is applied directly to the amplitude potentiometer which selects the amplitude applied to the power amplifier. The power amplifier can accept not only this amplitude signal but offset signals from the external input or the variable offset control. The output of the power amplifier is directly applied to the step attenuator which can

3.1.0 BLOCK DIAGRAM (Continued)

attenuate the signal in fixed db steps. Output of the attenuator is the main output connector for the generator. There are six power supplies in this generator, two of them being the unregulated raw supplies available directly at the filter capacitors. This voltage is a nominal 31 volts which is stepped down through the positive regulators for a plus 24 volt supply and a minus 24 volt supply. The plus and minus 24 volt supplies are used to provide voltage for the constant current sources as well as for the power amplifier. The plus and minus 24 volt supplies are reregulated through the plus and minus 15 volt regulators to provide all the operating potentials necessary for operation of the other circuitry.

The power supply regulating system that supplies a plus 3.2 and a minus 2.0 volts in reference to ground is provided such that the trigger amplifier, trigger comparators, and Run/Gate logic systems can be operated. The plus 3.2 volts is used in conjunction with a minus 4 volt regulator and the Function switch so that switching between the inverted and the non-inverting functions can be accomplished.

In order to lock out the main generator loop the application of the positive or negative current source for charging the timing capacitor is interrupted through the use of switching diodes and Lock Out current sources. The lock out current sources are used to sink the timing current available from the positive or negative current sources and clamp the timing capacitor voltage to the phase supply voltage. A signal available from the function switching network selects whether the positive or negative lock out current sources are activated. This then determines which direction the triangular waveform is going when the lock out condition occurs. These positive and negative lock out current sources derive their tracking signals from the positive and negative level shifters in the main generator loop. This allows them to operate at a current that tracks at 2 times the current supplied by the positive and negative current sources. This prevents a lock out level shift for a change in generator frequency dial In order that the generator can be made to always complete its last cycle of operation or complete the final portion of its cycle a lock out flip flop is used so that the application of the lock out current sources only occurs at the proper time. This lock out flip flop is buffered through the use of lock out driver amplifiers which are applied directly to the diode switches. Operation of this flip flop is arranged such that any input or set signal will override the reset signal and a continuous application of the set signal will yeild a continuous output such that the generator will run continuously. In order that both single cycle and a gated mode of operation can be realized a Gate/Trigger logic selects whether the Run command can be coupled through in a DC form or AC coupled such that a single pulse is provided for each input command. The main run command overrides all others and provides for free running operation through activation of this flip flop. In order to condition the external input signals for gated and triggered operation a trigger amplifier and a trigger comparator is used. The trigger comparator circuit is wired as a Schmitt trigger with appropriate feedback such that a reasonable amount of hysteresis is gained. This hysteresis provides for reliable triggering for both single shot and gated operation. The trigger amplifier is used to increase the gain of the trigger channel such that a very low signal of approximately 100 millivolts will trigger the Schmitt and a variable level control can increase this level to approximately 15 volts thereby creating a very wide dynamic range of external input capability The Manual trigger button will also apply the DC voltage necessary at the trigger amplifier to set the trigger comparator amplifier reliably.

3.1.0 BLOCK DIAGRAM (Continued)

The trigger amplifier receives its input from the Internal/External Logic which selects whether the main generator is triggered from an externally applied trigger signal or from the internal Ramp-Pulse generator. This Ramp-Pulse generator is used to generate the ramp waveform used for frequency sweeping, for burst operation or in generating the proper width for the pulse mode of operation. For operation in the sweep mode the ramp voltage generated in the ramp generator is applied through the sweep logic to the frequency supply and the Stop Frequency dial on the main generator. The VCF amplifier in the main generator is then used to take the difference between the Multiplier Start Frequency dial and the Stop Frequency dial generating a sweep width that is porportional to the difference of the settings. An extra amplifier called the V:F amplifier is provided to monitor the voltage at the output of the VCF amplifier so that a voltage porportional to frequency is available. The log linear logic provides for switching the ramp waveform used for sweeping to the log converter and applying its output to the Frequency Supply and the Stop Frequency dial for log sweep use.

The Ramp Pulse Generator utilizes a basic generator loop very similar to the main generator. It uses alternate current sources charging and discharging the timing capacitors. A very high input impedance ramp buffer amplifier is used to apply this signal then to the external loads for the ramp voltage and to the ramp level detector which is a bi-stable switch that controls the peak voltages of the ramp waveform. The output then of this ramp level detector is fed back to the current switch which selects either the ramp charging current source called the Ramp Positive Current Source or the ramp reset resistor. This connection closes the loop and provides a free running ramp generator. Decade frequency changes are realized by changing the value of the range capacitors in decade steps or changing range resistors in the Ramp Positive Current Source in decade steps. The Ramp Positive Current Source is also controlled by a DC voltage that makes it continuously variable over a wide range. This voltage is generated through the Ramp Positive Level Shift Amplifier. The Ramp Timing Supply directly applies a voltage to the Ramp Positive Level Shift Amplifier such that the voltage is proportional to ramp width. The ramp pulse timing supply accepts a feedback voltage from the Ramp Multiplier dial. This output then from the Ramp Timing Supply is applied also to a Ramp Negative Level Shift Amplifier which provides the variable operating levels for a Ramp Lockout Current Source. This Ramp Lockout Current Source is utilized in conjunction with the Ramp Lockout, Drivers and Trigger Comparator to lockout the basic ramp generating loop in a manner similar to the main generator loop. The Ramp Lockout Current Source is deactivated by the Ramp Lockout Drivers when it is desired to have a free running ramp waveform. The Ramp

3.1.0 BLOCK DIAGRAM (Continued)

Lockout Driver sinks the current from the Ramp Lockout Current Source. The Ramp Lockout Driver is supplied signal by the Ramp Lockout Flip-flop which controls the time at which the lockout current source is applied to the basic generator loop. The Ramp Lockout Flip-flop is a set/re-set type of flip-flop such that the input command from the Ramp Trigger Comparator can overrride the reset signal from the Ramp Level Detector. When a Ramp Run signal is supplied from the Ramp Run Logic the signal is coupled all the way through the chain deactivating the Ramp Lockout Current Source. In the triggered mode of operation the Ramp Trigger Comparator receives a signal that sets the flip-flop to the Run mode which couples through to the Ramp Lockout Drivers and the ramp current sources. This allows the ramp voltage to begin charging until it reaches the trip point of the Level Detector which trips, allowing the signal to change at the switching bridge for the timing capacitors. This starts the ramp in the other direction and at the same time switches the Ramp Lockout flip-flop. This allows the lockout driver to be activated such that the Ramp Lockout Current Source will be applied when the ramp voltage reaches the diode clamping voltage level supplied by the Ramp Lockout Voltage Source. The Ramp Trigger Comparator also receives signals from the manual pushbutton in the main generator to provide a single ramp waveform for each button activation. Depressing the Hold button allows the ramp waveform generated at the timing capacitors to be clamped to the Ramp Hold voltage source through the use of switching diodes and the ramp hold current source.

In the Pulse mode of operation the main generator Level Detector provides square pulses that trigger the Ramp Trigger Comparator providing a single ramp width for each main generator cycle such that a positive and a negative pulse is generated at the output of the Ramp Lockout Drivers that is porportional to the width of the ramp. This pulse then is processed through the Positive Pulse Level Control and the Negative Pulse Level Control. They are then applied through the Function switching network in the main generator which processes these signals through the pre-amplifier and the main power amplifier attenuator network to the main output connector of the generator. A ramp monitor amplifier is provided such that the ramp waveform can be continuously monitored as well at the ramp sync out. An amplifier is used to buffer this ramp sync pulse.

3.2.0 CIRCUIT DESCRIPTION

3.2.1 POWER SUPPLY (Figure 6.2.1)

The primary power for this instrument is supplied through the line cord to fuse F-100 which is selected for each voltage of operation. The primary power is then applied through the main power switch S-100 to the transformer primary and line voltage switch S-101A. The Line Voltage switch S-101 selects the method of connection for the primary taps so that a selection is available as to which line voltage the instrument will operate at. Transformer T-100 steps down the operating potentials of the input primary power so that the proper voltage is developed through the usage of diode bridge D-120A and filter capacitors C-120 and C-140. This full wave center tapped bridge rectifier setup provides both positive and negative operating potentials of sufficient magnitude to be regulated through the usage of the plus and minus 24 volt regulators. Integrated circuit Q-120 is a self contained voltage reference and error amplifier. The output of this error amplifier is fed to series pass transistor Q-125 which enhances the current carrying capability of Q-120. Resistor R-125 is a current sensing resistor that allows Q-120 to reduce the output voltage of the supply in the event the current reaches a predetermined value. The voltage feedback, necessary for the error amplifier, is derived through the usage of the voltage divider R-126 through R-128. The potentiometer R-127 provides for a vernier adjustment in the power supply voltage. Diode D-125 is used to prevent accidental application of negative voltage to the positive regulator. Application of negative voltage would damage the integrated circuit. Capacitor C-125 prevents the build up of transient voltage at the output of the supply under varying load conditions. The instrument power indicator I-100 is operated from the regulated 24 volt supply. The positive 24 volt supply is applied to a combination of Q-130 and Q-135 so that it can be re-regulated to provide a source of plus 15 volts. Integrated circuit Q-130 contains its own internal reference voltage and error amplifier so that when used in conjunction with series pass transistor Q-135 a precision source of power supply voltage is available. Resistor R-135 provides a current sensing voltage so that current limiting can be provided at a predetermined value. The voltage feedback signal necessary for closed loop operation is provided by resistive divider R-136 through R-138. Potentiometer R-137 provides for vernier adjustment in the value of the output voltage of the regulator. Diode D-135 prevents damage in the event of accidental application of a negative voltage to this positive regulating system. Capacitor C-135 prevents a voltage buildup due to transient loading on the output of the power supply. Transistors Q-140 through Q-160 provide a regulation of the negative raw voltage such that a minus 24 volts is produced. This regulator utilizes the positive 24 volt supply as a reference. Resistor R-156 through R-158 forms a voltage divider between the positive 24 volts and the negative 24 volts supply. The adjustable potentiometer provides a calibration adjustment for the -24 volt supply. A differential pair Q-150 and Q-155 then amplifies the difference between the voltage developed at the swinger of the potentiometer and a reference provided through resistor R-150. The Output signal then from this difference is applied to transistor Q-140 through R-141. Transistor Q-140 is phase compensated through capacitor C-141 and R-142 and its output then is applied through R-145 to the base of the series pass transistor Q-145.

3.2.1 POWER SUPPLY (Continued)

Resistor R-146 senses the current output of the supply by providi ng a voltage porportional to current that is applied to the base-emitter junction of transistor Q-160. Upon reaching the predetermined current limit, transistor Q-160 begins drawing current through diode D-160 and resistor R-161 upsetting the balance of the differential pair Q-150 and Q-155 so that output voltage is reduced. Capacitor C-160 prevents a voltage build up due to transient loading on the output of the power supply. Diode D-161 prevents accidental damage in the event of application of a reverse bias voltage to this supply. The negative 24 volts from this regulator then is supplied to the negative 15V regulator made up of transistors Q-165 through Q-180. Integrated circuit Q-165 is an operational amplifier whose input is derived from the resistive divider R-165 through R-167. The output of this voltage di vider is the difference between the positive 15 volt supply and the negative 15 volt supply. When these two supplies are equal and opposite the error voltage supplied to the operational amplifier Q-165 is zero and the supply is at rest or in a quiescent condition. The output of the operational amplifier Q-165 is fed through a level shifting diode D-165 to the bias and stablizing resistors R-170 and R-171. It is then applied to the base of transistor Q-170 operated as an emitter follower whose output is directly applied to the series pass transistor Q-175. Transistor Q-175 is operated as a series pass emitter follower transistor such that the operating current level of this supply can be supplied. Resistor R-175 provides a voltage porportional to current such that transistor Q-180 can be biased on at a predetermined current level. When this current level is reached Transistor Q-180 begins drawing current from the input of the operational amplifier Q-165. This current drawn from the input lowers the output voltage so that the output in effect will be current limited. Capacitor C-175 and C-176 prevent voltage build up at the output of the supply in the presence of varying loads on the supply. Diode D-175 prevents the application of reverse biasing potentials to the regulator that could result in damage.

3.2.2 LOGIC POWER SUPPLY (Figure 6.2.2)

The secondary winding of Transformer T-100 terminated in pins 8, 9 and 10 provides a voltage when rectified by Diodes D-100 and D-105 that is regulated to provide the plus 3.2 and minus 2.0 volt supply. The filter Capacitor C-101 is used to provide a ripple-free raw supply voltage to the integrated circuit regulator Q-100. Integrated circuit Q-100 contains an internal reference voltage as well as an error amplifier that is wired together with the external series pass transistor such that it maintains the difference between the input and output voltage at 5.2 volts. Voltage divider R-100, R-101 and R-102 provides the necessary adjustment in output voltage to maintain the proper operating level. Capacitor C-102 is a phase compensating network for the integrated circuit Q-100. Resistor R-105 is a current sensing resistor that allows the current limiting function of Q-100 to operate. Capacitor C-105 prevents the voltage build up due to varying load conditions on the supply. Diode D-106 prevents damage to the regulator in event of application of reverse biasing potentials. The nominal differential of the 5.2 volts provided by the regulator and series pass transistor is applied to the transistor network Q-515. This network together with bias resistors R-507, 508 and 519 maintains the plus 3.2 volts and minus 2.0 volts in reference to the instrument common. Capacitor C-516 filters out ripple due to varying loads that are unbalanced. Transistor Q-430 along with its voltage divider and biasing resistors R-430 through R-433 is used as a buffered supply of negative 4 volts. This supply is derived directly from the negative 15 volt regulated supply.

3.2.3 FREQUENCY CONTROL CIRCUITRY (Figure 6.3.1)

The frequency supply is a closed loop buffered operational amplifier system that provides a voltage for the multiplier dial. Operational amplifier Q-300 receives its input signal from R-304. R-306 is the feedback resistor that provides the necessary closed loop voltage gain. Transistor Q-310 is operated as an emitter follower to boost the current carrying capability of the frequency supply. The output of this frequency supply is applied directly to the rotary switch wired up as a Kelvin-Varley divider. This Kelvin-Varley divider has an extra position that allows the vernier potentiometer to span the full output voltage capability of the frequency supply. The output then of this Kelvin-Varley divider used as a frequency multiplier is applied through a summing resistor to the VCF amplifier. The VCF amplifier is capable of accepting a signal from the external VCF input or from the Multiplier dial. Integrated circuit Q-240 is an operational amplifier with an emitter follower buffer transistor Q-235. Q-235 enhances the current carrying capability of the VCF amplifier. Potentiometer R-243, the search range adjustment, injects a small current to the input of the VCF amplifier so that under normal operating conditions of the Multiplier dial, zero frequency can never be obtained and the maximum range of 1/1000th of the dial frequency is obtained Potentiometer R-246, the VCF balance control, compensates for the offset voltage of the amplifier Q-240. Resistors R-235 and R-237 provide the proper operating biases for the emitter follower transistor Q-235, and R-238 provides for a vernier adjustment of VCF amplifier gain or Frequency Adjust. The output of the VCF amplifier at the emitter of Q-235 is applied directly to the non-inverting input of the operational amplifier Q-275. It is also processed through frequency control connection schematic 2A for application to the input resistor R-269A. The output voltage at the output of the VCF amplifier is a nominal negative 5 millivolts to negative 5 volts for a frequency range of 1000 to 1. The most negative voltage being the highest frequency.

The level shift amplifiers are in reality voltage variable current sources whose outputs are taken from a pair of matched precision resistors referenced to equal and opposite power supplies. One level shift amplifier being driven from the negative input or inverting input and the other being driven in the non-inverting input provides equal and opposite polarities of output voltages suitable for driving the main current sources in the generator loop. The signal return path for R-269B at the input of Q-275 is routed through the frequency control connection schematic 2A. The current balance potentiometers R-265 and R-275 are utilized to balance out the internal offset voltage of the operational amplifiers Q-265 and Q-275. The field effect transistors Q-270 and 280 are used to buffer the output of the level shifting amplifiers in such a manner that the leakage currents are very small and output impedance is very high.

3.2.4 FREQUENCY CONTROL CONNECTIONS (Figure 6.3.2)

The sweep balance potentiometer R-300 is used to balance out the offset voltages and the frequency supply amplifier Q-300 so that the application of a sweep voltage from the ramp generator will maintain a linear relationship. The output of the VCF amplifier from Schematic 2 is applied through tp237 to tp269 at which point the Voltage Porportional to Frequency monitor amplifier is connected. This amplifier is a simple operational amplifier with equal input and feedback resistors providing an inverting voltage gain relationship of 1 to 1. Tp267 is a signal return for R-269B on schematic 2.

3.2.5 GENERATOR LOOP CIRCUITRY (Figure 6.4.1)

The positive and negative current sources receive their equal and opposite driving voltages from the level shifting amplifiers in schematic 2. The positive and negative current sources are operational amplifiers whose inputs are buffered with dual field effect transistors and whose output is taken from a single field effect transistor. The input signal at the gate of the dual field effect transistor Q-400 is applied to the positive input of the operational amplifier Q-405. The output of the operational amplifier Q-405 is applied to the gate of the field effect transistor Q-410 and as far as the closed loop amplifier is concerned the field effect transistor is operated as a source follower. The negative feedback for closed loop operation is from the source connection of the field effect transistor back to the gate input connection of the dual field effect transistor Q-400. The output of this source follower then is taken from R-403 center tap and applied to the negative input of the operational amplifier Q-405. The effective input resistor then to this closed loop amplifier is the set of range resistors R-405 through 409A. The input voltage to this current source varies between approximately plus 15 to plus 10 volts. Therefore, being operated as a closed loop amplifier the voltage at tp400 will remain the same as the input voltage and the current flowing through the range resistors will be controlled by the input voltage. The nature of a field effect transistor is such that the source current is very nearly equal to the drain current and thus the current flowing from the drain connection is controlled by the closed loop amplifying system. The negative current source comprised of Q-415, Q-420 and Q-425 operates in the same manner except that it is referenced instead to the negative 15 volt supply at the range resistors. The input voltage varies from negative 10 to negative 15 volts. The power supply connections for the operating potentials of the dual field effect input transistors and the operational amplifiers are derived from the plus and minus 24 volts available from the regulators. The value of current then supplied by these current sources to the timing capacitors is controlled by the input to the VCF amplifier and the range resistors. The positive and negative currents from the current sources are continually applied to the switching bridge which then allows the level detector square wave signal to apply alternately either one or the other of the current sources to the timing capacitor. The range switch selects a matched set of capacitors for different decade ranges of frequency operation. The triangular voltage developed across the timing capacitor is applied to a triangle buffer amplifier through filter R-435 and C-435. The triangle buffer amplifier is comprised of a very high input impedance source follower whose output is applied to two stages of emitter followers. Q-435A, Q-440A and Q-445A are these transistors. The operating bias potential for these transistors to operate with a zero offset from output to input is supplied by the matched counterpart to each device thus Q-435B, Q-440B and Q-445B. The field effect transistor Q-435B is operated at a gate source potential equal to the base emitter drops of the two transistors Q-440B and Q-445B. This field effect transistor then forces Q-435A, another field effect transistor, to operate at the same drain current thereby requiring the same gate to source potential. This potential being equal to the two transistor drops then realizes a zero output voltage from the input at C-435 to the output at tp456. Q-445A then being an emitter follower provides a low output impedance source of

3.2.5 GENERATOR LOOP CIRCUITRY (Continued)

triangular voltage to be applied to the level detector and to the function switching networks for processing in the output amplifiers and etc. The level detector consists of transistors Q-460 through Q-475. This detector receives its input through the compensated voltage divider consisting of R-458 and R-459. Capacitors C-455, 456 and 457 provide a high frequency lead network that compensates for the high frequency responses of the level detector network. Transistor Q-465 is a constant current source providing the operating currents for differential pair Q-460A and B. This differential pair of transistors is used to compare the triangular voltage developed at the divider network to the square wave voltage developed at resistor R-460. The square wave voltage developed at resistor R-460 is generated through the use of adjustable current supplies switched in through the use of the diode switching bridge network D-460 through D-463. The output of the differential input pair is applied to another differential pair, transistors Q-470 and Q-475. Diodes D-470 and D-471 clamp the collector voltages so that a small differential voltage can exist between the two. This maintains a current mode of operation enhancing high speed operation. The collector of transistor Q-475 and its load resistor R-468 provides a square wave that is clamped in amplitude by the limiting bridge diodes D-464, 465, etc. This square wave voltage is applied to the reference switching bridge D-460 through D-463 providing the positive feedback necessary for a bi-stable operation. Resistor R-451 and Diode limiting bridge D-451 through D-454 and resistor R452 is used to modify the reference voltage in the level detector developed at R460 for purposes of externally synchronizing the main generator loop.
The square wave output from the level detector is also fed to the sync output buffer through diodes D-481 and D-482. It also is applied to the switching bridge that selects either the positive or negative current source for the timing capacitors and the square amplifier that generates the square waveform that is applied to the pre-amplifier.

3.2.6 OUTPUT CONDITIONING CIRCUITRY (Figure 6.5.1)

The sine converter network receives its signal from the function selector only when a sine waveform is selected. The input level to this sine converting network is adjusted through potentiometer R-624 and the other associated resistors. The triangular input voltage is applied to all four of the diode switching bridges simultaneously, and the output of these bridges is summed together in a single resistor R-618. Various resistors such as R617, R-620 and R-637 are used to provide voltage breaking points that allow the currents to be changed in successive addition as the input voltage to the sine converting network goes from zero volts to say a positive or negative voltage. The sine waveform then appearing at the output summing resistor R-618 is applied to the input of the sine amplifier at Q-830A. Capacitor C-831 removes the high frequency components of the waveform before processing in the sine amplifier. The sine amplifier is a closed loop amplifier whose positive or non-inverting input is the base of Q-830A. Q-830A and 830B is a differential amplifier whose output is applied in Cascode form to transistor Q-835. The base of transistor Q-835 is elevated to a bias suitable for the maximum output voltage by diodes D-838 and temperature compensating diode D-837. The output

3.2.6 OUTPUT CONDITIONING CIRCUITRY (Continued)

of this stage is applied through two biased diodes D-835 and D-836 to the compound emitter followers Q-840 and Q-845. The negative feedback necessary for closed loop operation is provided by resistor R-846 to the effective input resistor R-847. Also paralleling R-847 is a vernier adjustment sine gain potentiometer R-836 and its limiting resistor R-837. The output of this sine amplifier is applied directly back to the function switching network through R-842. The square signal from the level detector in the main generator loop is applied to the current mode switch called a square amplifier through level shifting diode D-862. Transistors Q-860 and Q-850 are the current mode switch whose inactive input at the base of Q-850 is controlled by the combination of the Diodes D-850, 857 and the level adjusting potentiometer R-854. Adjusting the square gain potentiometer R-854 varies the base bias at the base of transistor Q-850 therefor varying its emitter bias through R-860 varying the level of the square output voltage. The collector load resistor for this output stage is R-855 and 856. R-855 being the square DC adjust potentiometer. Diode D-855 is a disconnect diode which allows the square amplifier to be deactivated by an external DC control signal available from the function switching network. This DC control signal is also applied to the base bias of Q-850 deactivating its operation when the square signal is not required. The output of this square amplifier is applied directly to the input of the pre-amplifier through R-608. The pre-amplifier then accepts signals through R-608 from the square amplifier when it is activated or from the function switching network through R-607. The pre-amplifier is a closed loop amplifier whose gain setting feedback resistor is R-757. This amplifier is a high performance amplifier with two signal paths, one containing the path for lower frequencies from DC to approximately 100 kilohertz and the other path for frequencies above 100 kilohertz. The feedback resistor R-757 is paralleled with a resistor of the same value R-758 for the fixed offset function. This reduces the gain of the amplifier by one-half and applies the fixed offset potential through R-708 and R-709.

The high frequency portion of this amplifier is comprised of two sets of Cascode amplifiers, that is, one set being Q-720 and Q-730 referenced to the plus 15 volts supply and the other being Q-725 and Q-735 referenced to the minus 15 volt supply. The outputs of these two Cascode amplifiers are connected together through bias diodes D-740 through D-746. The bias diodes provide the necessary quiescent operating bias for the input emitter followers Q-740 and Q-745. The summing junction or actual input connection to the amplifier is at the junction of the two high frequency input capacitors C-715 and C-725. The output of the input emitter followers Q-740 and Q-745 is applied to the output emitter followers through the bias diodes D-742 and D-747. Transistors Q-750 and Q-755 provide the necessary output current carrying capability through degeneration resistors R-750 and R-755. The Cascode stage comprised of Q-720 and Q-730 is operated as a slightly higher quiescent current than the opposite Cascode amplifier Q-725 and Q-735. This slightly higher current allows transistor Q-700D to be biased on at a quiescent potential thereby allowing a point to inject the signals from the low frequency or DC channel in the amplifier. The input connection to the amplifier applies the low frequency or DC signals through resistor R-701 to the base

3.2.6 OUTPUT CONDITIONING CIRCUITRY (Continued)

of differential transistor Q-700A. The differential output available from transistor Q-700 at the collectors and R-703 and R-704 is applied directly to another differential pair made up of transistors Q-700C and Q-700D. The single ended output from transistor Q-700D is applied directly through resistor R-715 to the Cascode amplifier Q-720 and Q-730. Potentiometer R-707, named the triangle DC adjust, compensates for variations in the offset of the differential amplifier Q-700.

The signals available from the output of the pre-amplifier are processed through de-coupling resistor R-759 to the amplitude front panel control resistor R-862. This potentiometer and its bottoming resistor R-859 provide a vernier control of the output amplitude of the generator. These signals are applied directly through gain controlling potentiometer 849 and amplitude setting resistor R-850 to the input of the closed loop output amplifier. The variable DC offset at potentiometer R-853 can also be applied through its switch S-837 to a gain setting resistor R-852 and to the input of the amplifier. Resistor R-848 provides a point for externally injecting a DC offset signal to the closed loop output amplifier.

The output amplifier is very similar to the pre-amplifier. This output amplifier has two signal paths for processing the input signals. One for low frequency signals from DC to approximately 100 kilohertz and the other for frequencies of approximately 100 kilohertz and above. The higher frequency signal path flows from the input connection through capacitors C-780 and C-785 to the bases of the two Cascode amplifiers. One amplifier being transistors Q-780 and Q-790 and the other being transistors Q-785 and Q-795. The signals are simultaneously applied to both amplifiers and the output then of these amplifiers are connected together and applied to the output emitter followers. Diodes D-800 through D-806 are bias diodes for generating a quiescent current for the input emitter follower stages Q-800 through Q-805. Bias diodes D-802 and D-807 provide a quiescent bias for the output transistors mounted to the heat sink Q-810 and Q-815. Degeneration resistors R-810 and R-815 applies the signal directly to the gain setting feedback resistor R-817 and the output impedance resistors R-820 through R-822. The Cascode amplifier referenced to the positive supply Q-780 and Q-790 is operated at a slightly higher current than the Cascode amplifier referenced to the negative supply. This higher current allows a small bias current to be drawn through R-775 by the differential amplifier Q-760C and Q-760D. This connection allows injection of the DC and low frequency signals to be processed through the amplifier. The low frequency input signals are coupled from the input connection through resistor R-761 to the base of the differential amplifier Q-760A. The differential output from this amplifier from its collectors and resistors R-763 and R-764 are applied directly to the differential amplifier Q-760C and Q-760D. The single ended output from Q-760D is applied directly to the Cascode through R-775. Resistor R-767 allows compensation for the voltage offset in the differential amplifier Q-760.

The attenuator is a series of T pad attenuators that can be either switched in or out by the manual pushbuttons in the front panel of the instrument. These T pad attenuators are arranged such that the 50 ohm transmission line impedance is maintained regardless of which or how many of the attenuators is activated.

3.2.7 FUNCTION SWITCHING (Figure 6.5.2)

The triangular waveform generated in the main generator loop is applied to switch deck S-700A which for either a sine or triangular waveform connection applies it directly to switch deck S-700B. The ramp waveform generated in the ramp generator is applied directly through switch deck S-700E when the ramp waveform is selected to gain setting resistor R-610. This waveform then is applied to switch S-700B which applies it directly to the pre-amplifier. S-700B also applies the triangular waveform from S-700A and the sine waveform from the sine amplifier directly to the pre-amplifier. (Switch deck S-700K is utilized to either activate or deactivate the square amplifier for the square waveform).

3.2.8 LOCKOUT LOGIC (Figure 6.6.1)

Integrated circuit Q-500 is a high speed differential amplifier. Q-500D section of the same is operated as a level boosting amplifier for the trigger input circuitry. The input signals for the trigger modes are from schematic 5A and processed through summing resistor R-504. The gate trigger potentiometer R-503 and the summing resistor R-502 provides a means of offsetting the current supplied through the external trigger voltages such that the trip point level can be varied over a very wide dynamic range. The resultant signal is applied to pin 6 positive input of the integrated circuit amplifier. The inverting input is terminated in a resistor R-509 and also at this point a signal from the manual pushbutton is injected through the use of R-505 and R-506. Capacitor C-500 prevents multiple triggering from contact bounce. The output of the integrated circuit amplifier Q-500D is fed directly into the positive input of Q-500A. Q-500A is wired such that it operates as a Schmitt trigger whose reference is the internal reference built into the differential amplifier package. The positive feedback necessary for Schmitt trigger action is through resistor R-500 and R-501. The output of the integrated circuit comparator is fed through relay K-510 and capacitor C-510 to the lockout flip-flop. Relay K-510 is controlled by the mode switching connections on schematic 5A. The lockout flip-flop is a set/re-set flip-flop with the capability of accepting an input on pin 12 for a continuous Run command as shown on schematic 5A. Any Run command applied to the inputs of Q-510A will override the re-set from Q-510B. As any Run command is removed from 510A then a re-set signal at the inputs of Q-510B will re-set the flip-flop causing the generator to lockout. The resistive dividers R-511 and R-510 and another divider R-514 and R-515 allow selection of the polarity of the lockout re-set signal. Voltages selected by the function selector in Schematic 6A are applied to these dividers activating only one divider at a time placing the switch point of the re-set inputs near its trip point potential. The opposite one then will be biased to a point out of the range of tripping Q-510B. The differential signal output available at Q-510A is applied directly to the differential pair Q-520 and Q-525. This transistor pair provides signals suitable for application to the main generator lockout current sources. The diode clamping networks D-516 through D-531 prevent saturation in the driver transistors. Tp518 and resistive divider R-516 through R-518 is capable of accepting a ground signal to place the generator in the free run mode.

3.2.9 MODE SWITCHING (Figure 6.6.2)

The external/internal switch which applies the signal to the main generator trigger input comparator through R-504 can receive a signal from the external trigger input connector J-500 or from the ramp buffer located on the ramp generator board at tp985. This ramp waveform can also be applied through the sweep switch S-513 to the Log-Lin switch S-205. S-205 selects whether the sweep voltage is processed through the log converter (Fig. 6.9.1) or not. The output of this switch S-205 is applied both through R-302 to pin 2 of Q-300 and to the Stop Frequency dial S-320. Q-300 is used as a voltage amplifier in this mode and the voltage that is applied to the VCF amplifier Q-240 then is the difference between the two dial settings. The sweep switch S-513 when activated accepts the gate command from the ramp generator for the gated sweep mode of operation. When the sweep switch is deactivted this same contact applies the gate control signal at Q-510A back through to the normal Run switch so that it can be activated manually in the other modes of operation. The other contact on the sweep switch receives 3.2 volts from the function selector S-700 during all normal symmetrical waveforms and applies it back then to the ramp Run switch S-1150. This connection allows the ramp generator to be placed into a Run mode when the sweep switch on the main generator is activated. The main generator Run switch S-515 receives 3.2 volts from tp506 at the switch's common contact. When activated this switch then applies the 3.2 volts to the normally closed contact on the Sweep switch and out then to the gate input at pin 12, Q-510A which applies a Run command directly to the gate input. The other contact on the Run switch S-515 receives the 3.2 volts from the function switch S-700 when the normal symmetrical waveforms are selected. The Run switch then when deactivated applies this 3.2 volts to the external-internal switch which will allow the ramp generator to be placed in a Run mode by this external-internal switch when internal triggered mode of operation is selected. The Gate/Trigger switch S-510 applies the 3.2 volts available from tp506 directly to relay K-510 and D-510 through a filtering capacitor C-512. This signal then activates the relay in the Gate mode allowing DC signals to couple through the trigger comparator to the lockout flip-flop. The Function Selector S-700 applies a Ramp Run command to the Ramp Run switch directly when the ramp waveform is selected. This function selector also applies the positive 3.2 volts to tp494 and the pulse relay when either of the pulse polarites are selected. The pulse relay applies the square wave signal available at the trigger out buffer in the main generator to the ramp trigger comparator at R-1156. This connection allows the main generator to set the repetition rate at which the ramp generator is triggered. The ramp generator then sets the pulse or ramp width so that a dual control mode of pulse operation is obtained.

3.2.10 LOCKOUT AMPLIFIER (Figure 6.7.1)

The lockout amplifier circuitry contains two voltage variable current sources of opposite polarities and a phase supply amplifier. The positive lockout current source is a closed loop operational, voltage variable current source. The input to this voltage variable current source is from the level shifting amplifiers in the main generator loop. The operation of these lockout current sources is the same as the main timing current sources with the exception that the output transistors in this case are discrete bi-polar transistors. The bi-polar transistors allow the output current level of these lockout current sources to operate at twice the main generator timing current as evidenced by the current setting resistors connected to the Range switch S-400D and S-400E. The output of the positive lockout current source is applied to lockout diodes D-342, 344, 346 and 341. Diodes D-343 and D-342 allow the lockout driver amplifier on schematic 5 to reverse bias diodes D-346 and 347 so that no current is drawn from the timing capacitor and buffer amplifier at tp422 on the main generator loop. Diodes D-345 and D-344 also allow the Function Selector S-700C to reverse bias diodes D-346 and 347. Diodes D-359 and D-360 receive a signal from the Function Selector also that allows then either one of these lockout current sources to be activated. By activating either polarity of current source the generator loop circuitry can be made to lockout a waveform going in either direction - positive or negative. The negative lockout current source also receives a signal from the lockout driver amplifiers at diodes D-358 and D-357. Assuming for the moment that the Function Selector has selected the positive current source for locking out then as the voltage at the main generator timing capacitor tp422 approaches the voltage of the phase supply amplifier a current begins to flow through Diodes D-346 and D-347 that approches the value of the main generator timing current. When it reaches this value then the value of current flowing through these two diodes is equal to the main timing current and no more current is allowed to flow into the timing capacitor. The lockout current source then being twice the main generator current level applies the same value of current through diodes D-341 and 340 to the output of the phase supply amplifier when the generator is locked out. The phase supply is a buffered operational amplifier whose input is derived from the phase control R-370. This operational amplifier is operated closed loop with feedback resistor R-373. The transistors Q-370 through Q-390 operate as a low output impedance buffer amplifier for the phase supply.

3.2.11 LOCKOUT SELECTOR (Figure 6.7.2)

The Function Selector S-700C can apply, depending on which function is selected, either the plus 3.2 volt supply or the minus 4.0 volt supply to tp511 on schematic 5. This connection then can either activate or deactivate this particular reset input for the lockout flip-flop. It is also applied to tp345 and tp359 which allows either lockout current source polarity to be applied to the main generator loop circuitry. Function Selector S-700D can also apply either positive 3.2 volts or the negative 4.0 volts to the Re-set input at the lockout flip-flop tp512. This connection selects the proper polarity for lockout signal depending on which polarity of waveform is selected.

3.2.12 RAMP LOCKOUT AND FREQUENCY CONTROL (Figure 6.8.1)

The ramp generator circuitry is very similar to the main generator loop circuitry. The basic idea being the constant current source charging and discharging the timing capacitor through a ramp buffer amplifier and to the ramp level detector. One major difference in the ramp generator being the charging of the timing capacitors with a constant current source - Ramp Timing current source - and the discharge being with a resistive current source. The ratio of these currents are set to provide a very fast re-set ramp waveform. The ramp timing amplifier Q-900 is a buffered operational amplifier whose output is applied directly to the ramp positive and negative level shifters. This output is also applied to the variable width control R-930. This potentiometer then varies the feedback ratio such that rotation is porportional to Ramp Pulse time. Ramp timing adjustment R-903 provides a constant input to the amplifier while Q-910 buffers the output current carrying capability of the amplifier. The positive and negative level shifting amplifiers are closed loop voltage variable current output amplifiers. The voltage outputs then at the drains of the two field effect transistors Q-945 and Q-1005 are opposite in polarity and referenced to the positive and negative 15 volt supplies. The positive signal then is applied to the ramp timing current source which is another voltage variable current source buffered at the input with Q-950, a dual field effect transistor, and buffered at the output Q-960, a single field effect transistor. Decade selection of the timing current is available at the Ramp-Pulse Width switch S-950A. The ramp negative level shifting amplifier is used to drive a ramp lockout current source which operates at twice the current of the ramp timing current source by nature of the fact its been driven by twice the voltage range. The ramp lockout current source is voltage variable closed loop current source whose input is buffered by dual field effect transistor Q-1010 and whose output is buffered by single field effect transistor Q-1020. Decade values of current selection are available at the Ramp-Pulse-Width switch S-950B. The ramp lockout voltage is always zero volts so the two lockout diodes D-950 and D-951 are referenced to the Ramp Lock Out Supply which is adjusted for a buffer output of zero during lockout. Diodes D-1010 through D-1013 allow the lockout current source to be applied only when the proper signals have been applied from both the level detector and the ramp lockout drivers. Diode D-1013 receives its signal from collector of Q-1110. This is the level detector output which allows then the lockout current source only to be applied when the ramp generator is in the proper state. Diode D-1011 receives its lockout command from the collector of transistor Q-1160 which is the lockout driver amplifier driven from the lockout flip-flop. The Ramp-Pulse-Width switch S-950 is used to select decade values of timing capacitors so that between the decade ranges of current available from the current sources and the decade ranges of timing capacitors all necessary ranges are provided. The ramp re-set current is provided through Diodes D-970 and D-971. For all ranges selected by S-950E except the lowest time ranges R-962 and R-963 are paralleled to provide the necessary re-set current. This current then is applied to the ramp timing capacitors by activation from Diodes D-961 and D-960, switching diodes for the output of the ramp level detector. On the shortest time range Resistor R-963 is de-activated and R-962 then becomes the sole re-set current source. The output of the ramp waveform generated at the timing capacitors is applied through the ramp buffer amplifier. This buffer amplifier consists of transistors Q-965,

3.2.12 RAMP LOCKOUT AND FREQUENCY CONTROL (Continued)

Q-975 and Q-980. Q-965A, Q-980A and Q-975A are the active transistors while Q-965B, 980B and 975B provide the necessary bias potential for the other transistors so that the zero offest voltage from the input of the buffer to the output of the buffer is obtained. Q-965A is a high imput impedance, field effect transistor whose output is applied as a source follower to emitter follower transistor Q-980. The output of the emitter follower Q-980 is applied directly to another emitter folower Q-975A. The emitter of Q-975A then is the output of the ramp buffer amplifier and it is applied then to the auxiliary ramp buffer Q-1200 and Q-1210, the ramp level detector, the function selector, and the mode control circuitry. The auxiliary ramp buffer is a complimentary emitter follower whose bias is obtained through the use of Diodes D-1200 and D-1210.

3.2.13 RAMP LEVEL DETECTOR AND LOCKOUT CIRCUITS (Figure 6.8.2)

The ramp waveform is applied to resistor R-1101 and R-1100, a voltage divider for the ramp level detector circuitry. This level detector then senses the difference through differential pair Q-1100A and Q-1100B between the voltage generated at the voltage divider and a reference voltage developed at R-1122 by constant current source R-1121 and R-1125. This constant current source is switched in and out by diodes D-1120 and D-1121. The output of the differential pair Q-1100 is applied to another differential pair Q-1110 and Q-1140. Two differential outputs are available that are clamped by diode bridges. The proper polarity is then applied back to switching diode D-1121 such that a positive feedback is applied creating a bi-stable mode of operation. As the ramp waveform approaches the reference level at R-1122 this level detector switches states and the ramp waveform then switches directions. Divider R-1123 and potentiometer R-1124 correct for any unbalance in the differential pair Q-1100. Transistor Q-1130 is a constant current source which maintains precise switching levels in the differential pair Q-1100. The output of the ramp level detector at Q-1110 is applied to a diode limiting bridge D-1110 through D-1116. It is also applied to reset the ramp lockout flip-flop through Capacitor C-1150. This voltage is also applied through the ramp sync amp, a high speed switching amplifier clamped by diodes D-1135 through D-1138. The voltage available at the level detector limiting bridge is also applied to the lockout current sources so that the lockout current is applied only at the proper time. The opposite polarity of level detector output available at the collector of Q-1140 is clamped by diode limiting bridge D-1140 through D-1146. This voltage then is directly applied to the ramp reset current switching diodes D-960 and D-961. The ramp lockout driver amplifier not only selects whether the lockout current source is applied to the ramp generating loop circuitry but generates a voltage level that is activated at the start of a ramp waveform and deactivated at the peak of the waveform. This signal then is processed through switching bridges that apply a positive and negative pulse amplitude to the generator function selector S-700.

3.2.13 RAMP LEVEL DETECTOR AND LOCKOUT CIRCUITS (Figure 6.8.2) Cont'd

The outputs of the ramp lockout driver amplifier are clamped with diode bridges so that highspeed current mode operation is maintained. The lockout driver itself is transistors Q-1160 and Q-1170 which receive differential output from the ramp lockout flip-flop Q-1150A. Diodes D-1190 through D1193 are level shifting diodes. The ramp lockout flip-flop receives its set or run command from either the Ramp Run switch S1150 or from the Ramp Trigger Comparator Q-500C. The Ramp Trigger Comparator is AC coupled through capacitor C-1151 such that a single ramp waveform is developed for each external trigger command. The Ramp Trigger Comparator is an integrated circuit amplifier wired as a Schmitt trigger. The input to this comparator then is directly applied from the ramp trigger input connector. The Ramp Trigger Comparator can also receive a signal from the manual pushbutton control or from the mode switching schematic at R-1156. R-1156 receives a signal only in the pulse mode of operation from the mode switching schematic. This signal allows the ramp generator to trigger once for each cycle that the main generator completes.

3.2.14 GATED SWEEP AND HOLD CIRCUITRY (Figure 6.8.3)

The gated sweep circuitry as shown on schematic 8A consists of the gated sweep switch, S-514, and the ramp run switch, S-1150B. S-514A provides the gating signals for the main generator. When activated this switch accepts gating signals from switch S-1150B; deactivated it applies 3.2 volts from the power supply to the mode switching circuitry on schematic 5A. When the ramp Run switch S-1150B is activated the gating signals for the main generator are supplied directly from the ramp level detector and when the ramp is operated in a triggered mode the gating signals for the main generator are supplied from the ramp lockout circuitry. S-514B accepts signals from the lockout circuitry of the main generator and applies them during gated sweep to level shifting amplifier Q-962 and Q-963. This amplifier inhibits the reset of the ramp generator so that the main generator is always allowed to complete its last cycle before the ramp is allowed to reset. The ramp Hold circuitry operates very nearly in the same manner as does the lockout circuitry of either generator. The system is comprised of a ramp hold current source, a ramp hold voltage source and the associated switching diodes that connect same to the generator loop. Transistor Q-1030, integrated circuit Q1035 and transistor Q-1040 form an operational current source whose input is derived from the ramp timing current sources on schematic 7. This input level tracks the ramp timing level so that a constant ramp hold voltage is obtained. Decade selection of the operating current is obtained through the use of S-950C. The output of this voltage variable current source is applied through tp1014 to the switching diodes D-954, D-955, D-1040 and D-1041. These diodes allow the voltage available from J-963 to be clamped to the voltage available at the output of the ramp hold voltage source at R-1051. The ramp hold voltage source is simply a buffered operational amplifier whose input is derived from

3.2.14 GATED SWEEP AND HOLD CIRCUITRY (Figure 6.8.3) Cont'd

the main power supplies. Voltage divider R-1072 and 1073 provides a vernier adjustment of the output level of this ramp hold voltage source. Resistor R-1074 is the feedback resistor for the closed loop operation while R-1052 and 1061 are biasing resistors. R-1071 is the input resistor to the inverting input of the integrated circuit operational amplifier. The reset circuitry for resetting the ramp generator to its starting point is also contained on this schematic and it is comprised of S-972, the Reset switch, and Q-1125, a switching transistor. S-972A is used to apply the charge available on capacitor C-1120 to the base of Q-1125. Activation of this switch saturates Q-1125 so that the ramp level detector on schematic 8 is reset to its proper state for the beginning of a new ramp. S-972B selects a current source for resetting the ramp voltage at J-963 through the use of a switching bridge D-972 through D-974.

3.2.15 LOG CONVERTER (Figure 6.9.1)

The heart of the logarithmic conversion is the application of nonlinear integrated circuit Q-220 to the feedback circuitry of an operational amplifier Q-200. The input signals for this operational amplifier are supplied by a buffer amplifier Q-190. This buffer amplifier is a non-inverting unity gain operational amplifier whose output is directly connected to summing resistor R-219. The output of the log converting amplifier is applied directly to the non-inverting input of another buffer amplifier Q-230. The feedback signal for Q-200 is applied directly to Q-220 the nonlinear element and also through another channel that has a boosting amplifier Q-210. A differential output signal is taken from Q-220 and applied as feedback to the amplifier Q-200 through resistors R-204 and R-214. Buffered amplifiers Q-205 and Q-215 provide a precision source of power supply voltage for amplifiers Q-200, Q-210 and the nonlinear element Q-220. This low value of power supply voltage provides a limiting action within each stage. Transistor Q-206 is an emitter follower buffer which enhances the current carrying capability of this supply. Transistor Q-216 also enhances the current carrying capability of the negative supply. The input for these supplies is derived directly from the normal instrument supply voltage of plus and minus 15 volts. Divider network R-205 through R-215 applies the proper voltage to the non-inverting inputs of each supply amplifier. The output of the log converter is applied directly through tp230 to the log linear switch S-205.

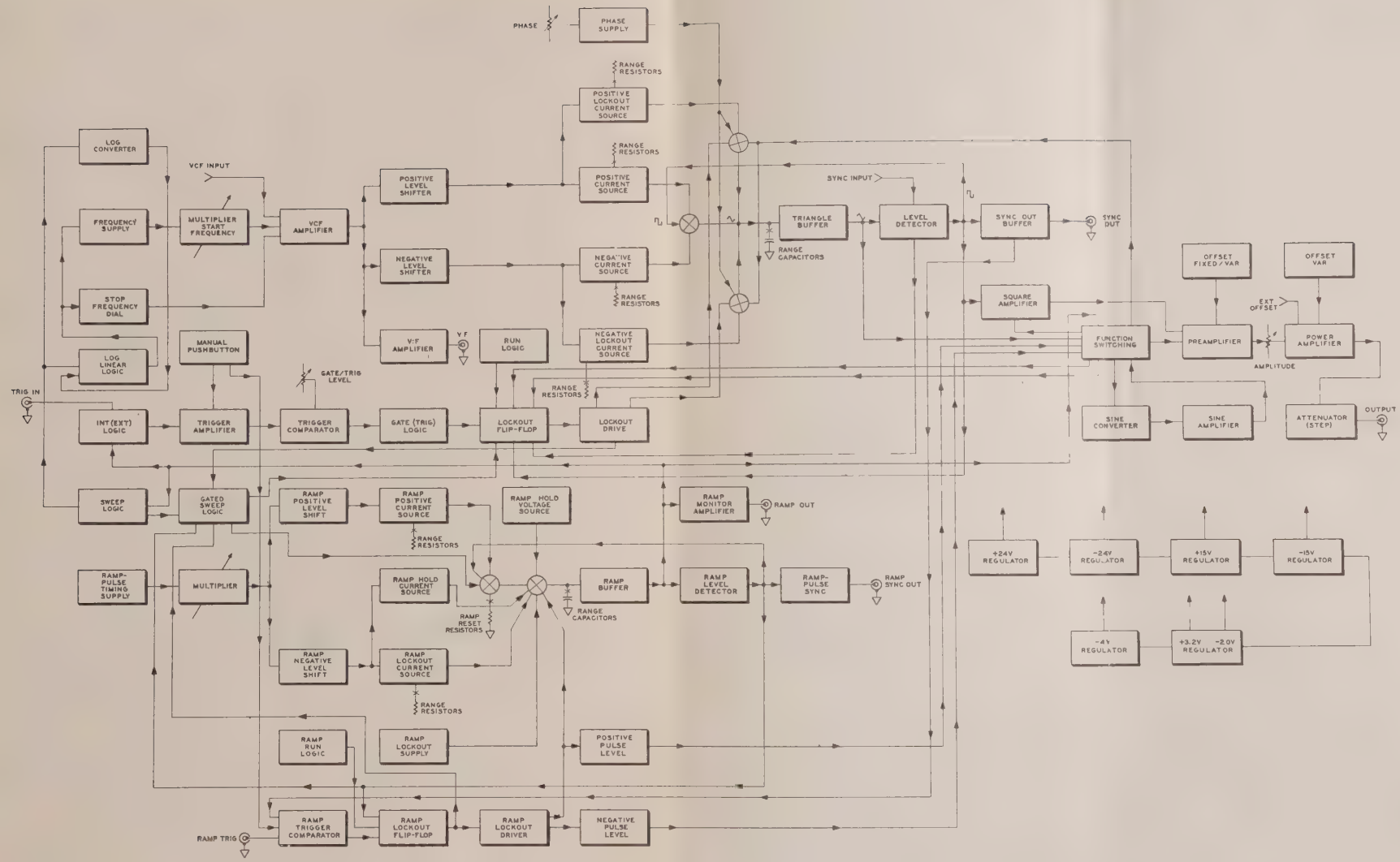
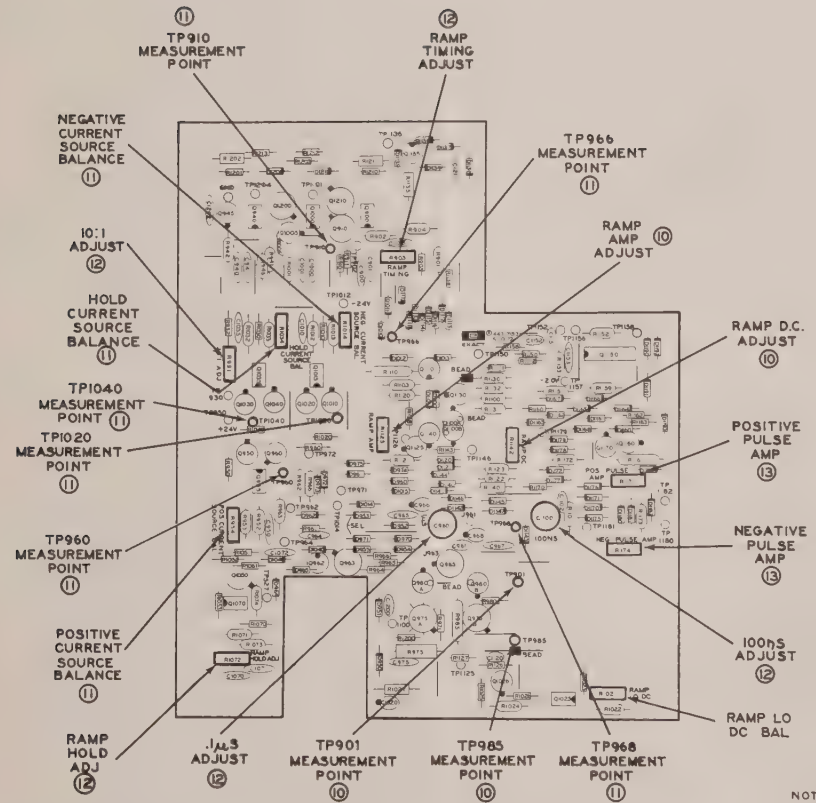
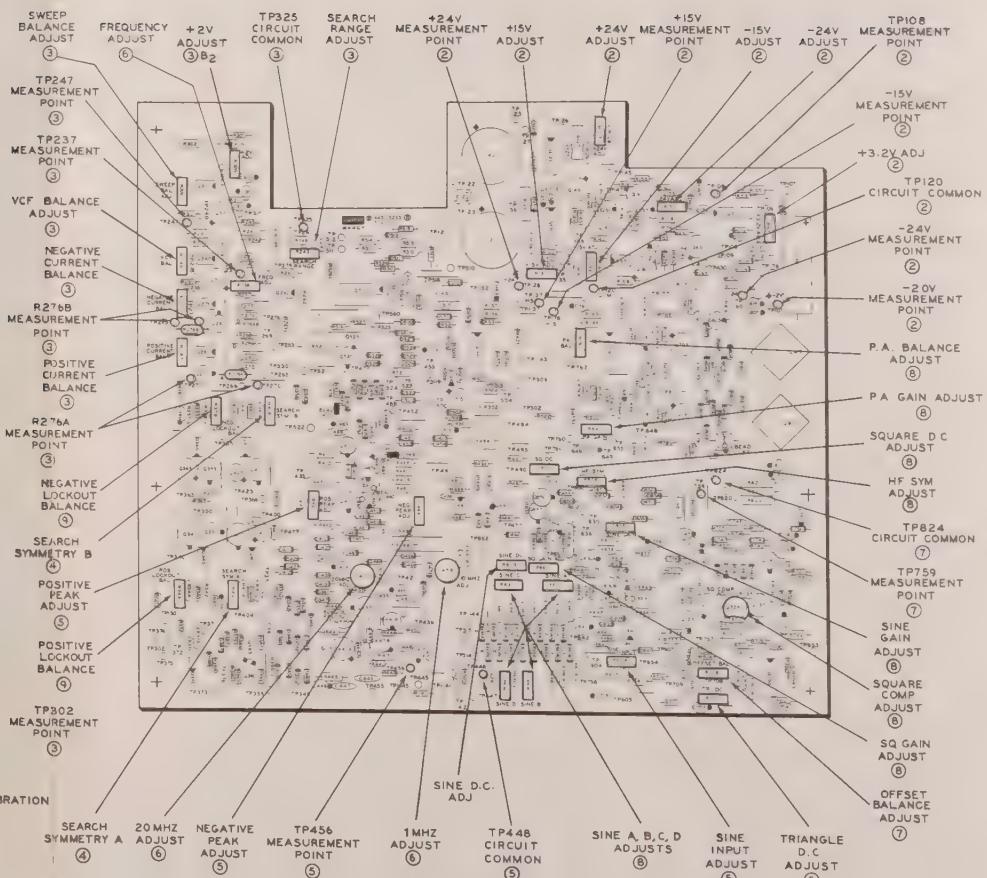


FIGURE 3.11
BLOCK DIAGRAM (E)


⑪ TP910 MEASUREMENT POINT
⑫ RAMP TIMING ADJUST
NEGATIVE CURRENT SOURCE BALANCE ⑪
TP966 MEASUREMENT POINT ⑪
RAMP AMP ADJUST ⑩
10:1 ADJUST ⑫
HOLD CURRENT SOURCE BALANCE ⑪
RAMP D.C. ADJUST ⑩
TP1040 MEASUREMENT POINT ⑪
TP1020 MEASUREMENT POINT ⑪
POSITIVE PULSE AMP ⑬
NEGATIVE PULSE AMP ⑬
TP960 MEASUREMENT POINT ⑪
POSITIVE CURRENT SOURCE BALANCE ⑪
100nS ADJUST ⑫
RAMP LO DC BAL
RAMP HOLD ADJ ⑫
.1μS ADJUST ⑫
TP901 MEASUREMENT POINT ⑩
TP985 MEASUREMENT POINT ⑩
TP968 MEASUREMENT POINT ⑪

NOTE :
1. ○ INDICATES CALIBRATION SEQUENCE

FIGURE 4.1.1
ADJUSTMENT LOCATION DETAIL
(E)



NOTES:
1. ○ INDICATES CALIBRATION SEQUENCE

FIGURE 4.1.0
ADJUSTMENT LOCATION DETAIL
(J)

10. Set Function to Ramp; Ramp time to 10ms; Attenuators to 0db (all out); Offset, Fixed and Variable, Off (out); Run pushbutton in (Run) and Hold at Off (out). (Figure 4.1.1)

A. Connect oscilloscope to tp985 with tp901 as common.
B. Adjust RAMP AMP to obtain +2.00V (+10mv -0mv) at + ramp peak.
C. Adjust RAMP DC ADJUST to obtain 0V ± 10mv at - peak.

11. Connect DVM to tp910 using tp901 as common.
Note: DVM must be floating to avoid damage to generator during following measurements.

A. Set ramp time variable maximum ccw and note voltage (approx. 400mv).
B. Connect DVM from tp960 to tp966 (+15V). Adjust the Positive Current Source Bal to obtain 1/2 the voltage previously measured at tp910 ±2mv.
C. Connect DVM from tp1020 to tp968 (-15V) and adjust Negative Current Source Bal to obtain the same voltage as tp910 ± 2mv.
D. Connect DVM from tp1040 to tp968 (-15V) and adjust the Hold Current Source Bal to obtain the same voltage as tp910 ± 2mv.

12. Set Run pushbutton at Lockout (out) and Hold button at Hold (in).

A. Connect DVM to tp985 with tp901 as common. Depress the MAN trigger button to cause ramp to run to the peak and hold.
B. Adjust Ramp Hold Adjust to obtain 2.00V +10mv -0mv in Hold.
C. Depress the reset pushbutton switch to cause ramp to reset to 0V.
D. Adjust 'Ramp L.O. DC Adjust' to obtain 0V +0mv -5mv.

13. Set Run pushbutton at Run (in) and Hold button at Off (out). Connect a time counter to the Ramp Sync Output on rear panel terminated into 50Ω. Set the counter to read time interval A-B + to - slope.

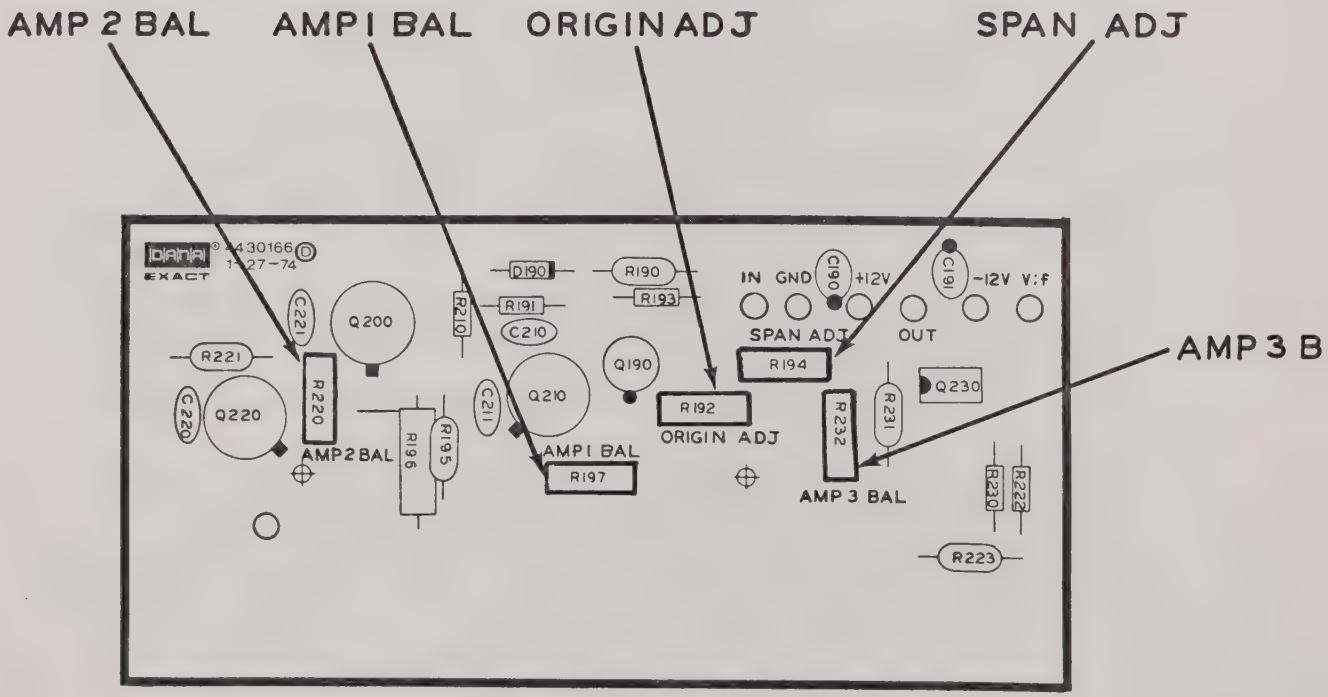
A. Adjust 10:1 ADJUST to obtain a >10:1 time period ratio when the ramp time variable is rotated from the Cal Position to full counterclockwise. Set to approx. 11:1 to ensure >10:1 range on variable.
B. Adjust ramp timing to obtain 10ms when the ramp variable is in the Cal position. Repeat A and B if necessary.
C. Set Ramp Time to 100ns and VAR to the Cal position. Adjust 100ns Adj. to obtain 100ns ± 2ns. NOTE: If counter does not count this fast, use oscilloscope.
D. Set VAR to full CCW. Adjust the .1μ SEC ADJ to obtain 1000ns ± 20ns.
E. Repeat C and D if necessary.

14. Set Function at Pos Pulse, Rep Rate at 100 Hz, Start Frequency at 1.0, Ramp Pulse Width at 1ms, Variable to Cal and Amp to full clockwise (max.) Depress both main generator and ramp generator Run buttons.

A. Monitor Pos Pulse at main output with oscilloscope terminated into 50Ω and adjust the Pos Pulse Amp to obtain +7.5V peak +20mv -0mv.
B. Set Function at Neg Pulse. Adjust the Neg Pulse Amp to obtain -7.5V peak -20mv +0mv.

15. Set Frequency at S.X, Range at 100K, Run pushbutton in, Gate at Off (out), Function at Triangle, Ramp Time at 1ms., Variable at Cal., Ramp pushbutton In. Refer to figure 4.1.2.

A. Adjust AMP 1 BAL for 0mv offset between Pins 2 and 3 of Q210.
B. Adjust AMP 2 BAL for 0mv offset between Pins 2 and 3 of Q220.
C. Adjust AMP 3 BAL for 0 mv offset between Pins 2 and 3 of Q230.
D. Set Multiplier to S.O with an output of 100Hz in the Linear Mode. Press Log Mode button 'IN' to Log Mode and adjust ORIGIN for 100Hz output.
E. Set Multiplier to S.X and adjust SPAN to obtain the same output frequency in Lin and Log Modes.



CHECK LOG LINEARITY

1. Range 100 KHz
   Mult S.O
   Main Mode Run
   Lin/Log SW Log

   Monitor frequency on counter with 0V ± 1mv connected to the VCF input and adjust search vernier to obtain 100 Hz ± 2Hz.

2. Apply positive voltage at VCF input until frequency increases to 100 KHz ± 500 Hz and record input voltage.

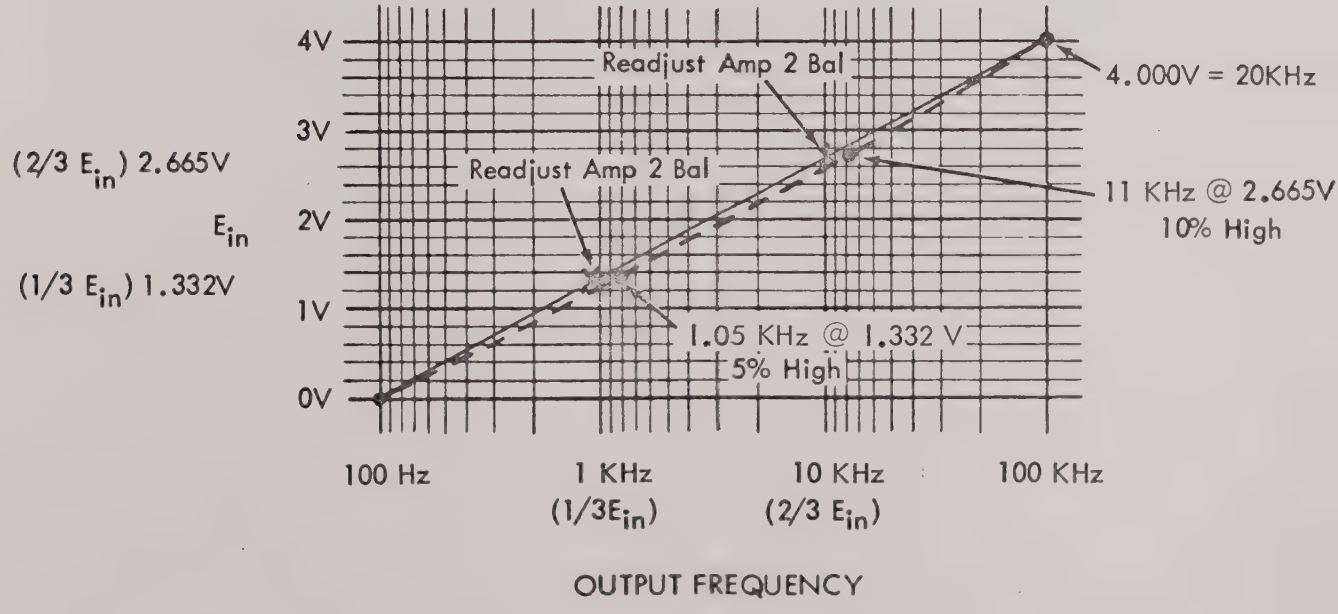
3. Multiply input voltage by 1/3 and 2/3.

4. Apply $2/3E_{in\ max}$ at VCF input and observe 10 KHz ± 500 Hz.

5. Apply $1/3E_{in\ max}$ at VCF input and observe 1 KHz ± 50Hz.

6. Adjust Amp 2 BAL to correct linearity if required at approximately 10%/mv.

EXAMPLE:



Step 1:

Range	100K
Mult	S.O
Main Mode	Run
Lin/Log SW	Log

Monitor output frequency on counter with 0V ± 1mv connected to VCF input and adjust search vernier to obtain 100 Hz ± 2 Hz.

Step 2:

VCF Voltage	Output Frequency
4.00V	100 KHz

Step 3: 4.00 X 2/3 = 2.665
4.00 X 1/3 = 1.332

Step 4: E_{in} = 2.665 F_{out} = 11.0 KHz (should be 10 KHz)

Step 5: E_{in} = 1.332 F_{out} = 1.05 KHz (should be 1 KHz)

Step 6: In the above example, both frequency readings are high indicating a slight bow in the curve. When both readings are high, as in the above example or both low; the "bow" may be decreased by adjusting Amp 2 BAL as indicated in #6 of the Log Linearity check.

In this case, the frequency was 10% high at 10 KHz and 5% high at 1 KHz. By readjusting Amp 2 BAL 1mv more negative than its original setting, it will decrease the frequency from 11 KHz (10% high) to approximately 10 KHz, and from 1.05 KHz (5% high) to approximately .95 KHz (-5%) as indicated on the graph.

By carefully adjusting Amp 2 BAL, the curve may be adjusted to its optimum linearity (when the error at 10 KHz is equal and opposite to the error at 1 KHz).

SECTION 5

PARTS LIST

CODE LIST OF MANUFACTURERS

Code No.	Manufacturer	Address
00001	U.S.A. Common	Any supplier of U.S.
00136	McCoy Electronics	Mount Holly Sprgs, Pa.
00213	Sage Electronics Corp.	Rochester, N.Y.
00334	Humiseal Co.	Colton, Calif.
00355	Westrex Corp.	New York, N.Y.
00375	Garlock Packing Co., Electronic Prod. Div.	Camden, N.J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp, Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N.J.
00915	Northern Eng. Labs, Inc.	Burlington, Wis.
00853	Sangamo Electric Co. Ordill Div. (Caps)	Marion, Illinois
00866	Goe Engineering Co.	Los Angeles, Calif.
0089	Carl E. Holmes Corp.	Los Angeles, Calif.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Calif.
01281	TRW Semiconductors Inc.	Lawndale, Calif.
01295	Texas Instruments, Inc. Transistor Prod. Div.	Dallas, Texas
01349	The Alliance Mfg. Co.	Alliance, Ohio
01356	Chasi-Trak Corp.	Indianapolis, Inc.
01589	Pacific Relays, Inc.	Van Nuys, Calif.
01930	Amerock Corp.	Rockford, Illinois
01961	Pulse Engineering Co.	Santa Clara, Calif.
02114	Ferroxcube Corp/Amer.	Saugerties, N.Y.
02286	Cole Mfg. Co.	Palo Alto, Calif.
02660	Amphenol-Borg El. Corp.	Chicago, Illinois
02735	Radio Corp. of America, Semiconductor and Materials Div.	Somerville, N.J.
02771	Vocaline Company of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Calif.
03508	G.E. Semiconductor Products Dept.	Syracuse, N.Y.
03705	Apex Machine and Tool Co.	Dayton, Ohio
03797	Elsema Corp.	El Monte, Calif.
03877	Transitron Electronic Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co.	Morristown, N.J.
03954	Air Marine Motors, Inc.	Los Angeles, Calif.
04009	Arrow, Hart and Hegeman Electric Co.	Hartford, Conn.
04013	Taurus Corp.	Lambertville, N.J.
04062	Elmenco Products Co.	New York, N.Y.
04222	Hi-Q, Division of Aerovox	Myrtle Beach, S.C.
04298	Elgin National Watch Co. Electronics Div.	Burbank, Calif.
04354	Precision Paper Tube Co.	Chicago, Illinois
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.
04651	Sylvania Electric Prod., Inc. Electronic Tube Div.	Mountain View, Calif.
04713	Motorola/Semicon. Prod.	Phoenix, Arizona
04732	Filtron Co/Western Div.	Culver City, Calif.
04773	Automatic Electric Co.	Northlake, Illinois
04777	Automatic Elect. Sales Corp.	Northlake, Illinois
04796	Sequoia Wire/Cable Co.	Redwood City, Calif.
04811	Precision Coil Spring Co.	El Monte, Calif.
04870	P.M. Motor Co.	Chicago, Illinois
05006	20th Century Plastics	Los Angeles, Calif.
05277	Westinghouse/Semicon. Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Calif.
05393	Illuminteck Eng. Co.	Sunnyvale, Calif.
05616	Cosmo Plastic (c/o Electrical Spec. Co.)	Cleveland, Ohio
05624	Barber Colman Co.	Rockford, Illinois
05728	Tiffen Optical Co.	Roslyn Heights, L.I., N.Y.
05729	Metropolitan Telecomm. Corp Metro Cap Div.	Brooklyn, N.Y.
05783	Stewart Engineering Co.	Santa Cruz, Calif.
05820	Wakefield Engineering Inc.	Wakefield, Mass.
06004	The Bassick Co.	Bridgeport, Conn.
06 75	Bausch and Lomb Optical	Rochester, N.Y.
06402	E.T.A. Products/Amer.	Chicago, Illinois
06475	Western Devices, Inc.	Inglewood, Calif.
06540	Amaton Elect. Hardware Co.	New Rochelle, N.Y.
06555	Beede Electrical Inst.Co.	Penacook, N.H.
06751	U.S. Semcar Div. of Nuclear Corp/Amer.	Phoenix, Ariz.
06812	Torrington Mfg Co., West Div.	Van Nuys, Calif.
07088	Kelvin Electric Co.	Van Nuys, Calif.
07115	Corning Glass Works Electronics Comp. Dept.	Bradford, Pa.
07126	Digitron Co.	Pasadena, Calif.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N.Y.
07149	Filmohm Corp.	New York, N.Y.
07233	Cinch-Graphik Co.	City of Industry, Calif.
0726	Avnet Corp.	Los Angeles, Calif.
07263	Fairchild Semiconductor Corp.	Mountain View, Calif.
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07387	The Bircher Corp.	Los Angeles, Calif.
07390	Technical Wire Products	Springfield, N.J.
07490	Continental Device Corp.	Hawthorne, Calif.
07533	Rheem Semiconductor Corp.	Mountain View, Calif.
07706	Shockley Semi-Conductor Labs	Palo Alto, Calif.
07980	Boonton Radio Corp.	Boonton, N.J.
08045	U.S. Engineering Co.	Los Angeles, Calif.
08289	Blinn, Delbert, Co.	Pomona, Calif.
08358	Burgess Battery Co.	Niagara Falls, Ontario
08707	Sloan Company	Burbank, Calif.
08858	Cannon Elect Co., Phoenix Div.	Phoenix, Ariz.
08982	CBS Elect. Semiconductor Oper., Div. C.B.S., Inc.	Lowell, Mass.
09884	Mal-Rain	Indianapolis, Ind.
09926	Babcock Relays, Inc.	Costa Mesa, Calif.
09934	Texas Capacitor Co.	Houston, Texas
09945	Atohm Electronics	Sun Valley, Calif.
09954	Electra Assemblies, Inc.	Chicago, Illinois
09965	Mallory Battery Co/Canada Ltd.	Toronto, Ontario, Canada
09984	The Bristol Company	Waterbury, Conn.
09994	Gen. Trans. Western Corp.	Los Angeles, Calif.
0998	Tri-tal, Inc.	Parkelay, Calif.
09999	Exact Electronics, Inc.	Hillsboro, Oreg.
10040	Carborundum Co.	Niagara Falls, N.Y.
10136	CTS of Berne, Inc.	Berne, Ind.
10137	Chicago Tel. of Calif., Inc.	S. Pasadena, Calif.
10182	Microwave Elect. Corp.	Palo Alto, Calif.
10254	Duncan Electronic, Inc.	Santa Ana, Calif.
10401	Gen'l Inst/Semiconductor Div	Newark, N.J.
10721	Imperial Electronic, Inc.	Buena Park, Calif.

Code No.	Manufacturer	Address
11870	Melabs, Inc.	Palo Alto, Calif.
12136	Philadelphia Handle Co.	Camden, N.J.
12697	Clarostat Mfg. Co.	Dover, N.H.
12859	Nippon Elect. Co., Ltd.	Tokyo, Japan
12930	Delta Semiconductor Inc.	Newport Beach, Calif.
13103	Thermalloy	Dallas, Texas
13396	Telefunken (G,M,B.H.)	Hannover, Germany
13835	Midland Mfg. Co.	Kansas City, Kansas
14099	Sen-Tech	Newbury Park, Calif.
14193	Calif. Resistor Corp.	Santa Monica, Calif.
14298	American Components Inc.	Conshohocken, Pa.
14655	Cornell Dubilier El. Corp.	So. Plainfield, N.J.
14960	Williams Mfg. Co.	San Jose, Calif.
15203	Webster Elect., Co., Inc.	Brooklyn, N.Y.
15291	Adjustable Bushing Co.	N. Hollywood, Calif.
15772	Twentieth Century Coil Spring Co.	Santa Clara, Calif.
15909	The Daven Co.	Livingston, N.J.
16037	Spruce Pine Mica Co.	Spruce Pine, N.C.
16352	Computer Diode Corp.	Lodi, N.J.
16688	De Jur-Amsco Corp.	Long Island City, N.Y.
16758	Delco Radio Division of G.M. Corp.	Kokomo, Ind.
17109	Thermonetics, Inc.	Canoga Park, Calif.
17474	Tranex Company	Mountain View, Calif.
18486	Radio Industries	Des Plaines, Illinois
18583	Curtis Instrument, Inc.	Mt. Kisco, N.Y.
18873	E.I. Dupont and Co., Inc.	Wilmington, Del.
19315	Eclipse Pioneer, Div. of Bendix Aviation Corp.	Teterboro, N.J.
19500	Thomas A. Edison Industries Div. McGraw-Edison Co.	West Orange, N.J.
19701	Electro Manufacturing Co.	Kansas City, Mo.
20183	Electronic Tube Corp.	Philadelphia, Pa.
21226	Executive, Inc.	New York, N.Y.
21520	Fansteel Metallurgical Corp.	No. Chicago, Illinois
21335	The Fafnir Bearing Co.	New Britain, Conn.
21964	Fed. Telephone and Radio Corp.	Clifton, N.J.
24446	General Electric Co.	Schenectady, N.Y.
24455	G.E. Lamp Div.	Nela Park, Cleveland, Ohio
24655	General Radio Co.	W. Concord, Mass.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Grobet File Co/America, Inc.	Carlstadt, N.J.
26992	Hamilton Watch Co.	Lancaster, Pa.
28480	Hewlett-Packard Co.	Palo Alto, Calif.
33173	GE Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm, Inc.	Chicago, Ill.
36196	Stanwyck Corp.	Hawkesburn, Ontario, Cd.
37942	P.R. Mallory and Co., Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod.	Akron, Ohio
40920	Miniature Precision Bearings	Keene, N.H.
42190	Muter Co.	Chicago, Illinois
43990	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Illinois
47904	Palaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer/Inst.	Philadelphia, Pa.
49956	Raytheon Company	Lexington, Mass.
52090	Rowan Controller Co.	Baltimore, Md.
63743	Ward Leonard Electric	Mt. Vernon, N.Y.
64294	Shallcross Mfg. Co.	Selma, N.C.
65026	Simpson Electric Co.	Chicago, Illinois
65933	Sonotone Corp.	Elmsford, N.Y.
65938	Sorenson and Co., Inc.	S. Norwalk, Conn.
66137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
66289	Sprague Electric Co.	N. Adams, Mass.
59446	Telex, Inc.	St. Paul, Minn.
59730	Thomas and Betts Co.	Elizabeth, N.J.
60741	Tripplett Electrical Inc.	Bluffton, Ohio
61775	Union Switch and Signal, Div. Westinghouse Air Brake Co.	Swissvale, Pa.
62119	Universal Electric Co.	Ossoso, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	West Inst./Div. Daystrom	Newark, N.J.
66295	Wittek Manufacturing Co.	Chicago, Illinois
66346	Wollensak Optical Co.	Rochester, N.Y.
70276	Allen Manufacturing Co.	Hartford, Conn.
70309	Allied Control Co., Inc.	New York, N.Y.
70319	Allmetal Screw Prod. Co, Inc.	Garden City, N.Y.
70485	Atlantic Indio Rubber Works	Chicago, Illinois
70563	Amperite Co., Inc.	New York, N.Y.
70903	Belden Manufacturing Co.	Chicago, Illinois
70998	Bird Electronic Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.
71218	Bud Radio Inc.	Cleveland, Ohio
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Allen D. Cardwell Elect. Prod. Corp.	Plainville, Conn.
71400	Bussmann Fuse Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Illinois
71450	CTS Corp.	Elkhart, Ind.
71468	Connor Electric Co.	Los Angeles, Calif.
71471	Cinema Engineering Co.	Burbank, Calif.
71482	C.P. Clare and Co.	Chicago, Illinois
71590	Centralab, Div. Globe Union, Inc.	Milwaukee, Wis.
71616	Commercial Plastics Co.	Chicago, Illinois
71700	The Cornish Wire Co.	New York, N.Y.
71744	Chicago Miniature Lamp Wks	Chicago, Illinois
71753	A. O. Smith Corp. Crowley Div.	West Orange, N.J.
71785	Cinch Mfg. Corp.	Chicago, Illinois
71984	Dow Corning Corp.	Midland, Mich.
72092	Etel-McCullough, Inc.	San Bruno, Calif.
72136	Electro Motive Mfg. Co, Inc.	Willimantic, Conn.
71707	Cato Coil Co., Inc.	Providence, R.I.
72354	John E Fast and Company	Chicago, Illinois
72619	Dialight Corp.	Brooklyn, N.Y.
72656	General Ceramics Corp.	Keasbey, N.J.
72699	General Instrument Corp. Semiconductor Div.	Newark, N.J.
72758	Girard-Hopkins	Oakland, Calif.
72765	Drake Mfg. Co.	Chicago, Illinois
72825	Hugh H. Eby, Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Illinois
72965	Robert M. Hadley Co.	Los Angeles, Calif.
72982	Erie Resistor Corp.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73076	H. M. Harper Co.	Chicago, Illinois
73138	Helipot, Div, Beckman Instruments, Inc.	Fullerton, Calif.

Code No.	Manufacturer	Address
73293	Hughes Products Div. of Hughes Aircraft Co.	Newport Beach, Calif.
73445	Amperex Electronic Co., Div. No. American Philips Co., Inc.	Hicksville, N.Y.
73490	Beckman Helipot Corp.	S. Pasadena, Calif.
73506	Bradley Semiconductor Corp.	Hamden, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73682	George K. Garrett Co., Inc.	Philadelphia, Pa.
73734	Federal Screw Prod. Co.	Chicago, Illinois
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	The General Industries Co.	Elyria, Ohio
73846	Goshen Stamping and Tool	Goshen, Ind.
73899	JFD Electronics Corp.	Brooklyn, N.Y.
73905	Jennings Radio Mfg. Co.	San Jose, Calif.
74276	Signalite, Inc.	Neptune, N.J.
74455	J. H. Winns and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Illinois
74868	R.F. Prod. Div. of Amphenol-Borg Electronics Corp.	Danbury, Conn.
74970	E.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75173	Jones, Howard B., Div. of Cinch Mfg. Corp.	Chicago, Illinois
75378	James Knights Co.	Sandwich, Illinois
75382	Kulka Electric Corp.	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Illinois
75915	Littlefuse, Inc.	Des Plaines, Illinois
76005	Lord Mfg. Co.	Erie, Pa.
76210	C,W, Marwedel	San Francisco, Calif.
76433	Micamold Electronic Mfg. Corp	Brooklyn, N.Y.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Calif.
76530	Monadnock Mills	San Leandro, Calif.
76545	Mueller Electric Co.	Cleveland, Ohio
76854	Oak Manufacturing Co.	Crystal Lake, Illinois
77068	Bendix Pacific Div. of Bendix Corp.	N. Hollywood, Calif.
77075	Pacific Metals Co.	San Francisco, Calif.
77221	Praastran Instrument and Electronic Co.	S. Pasadena, Calif.
77250	Rhoell Manufacturing Co.	Chicago, Illinois
77252	Philadelphia Steel and Wire Corporation	Philadelphia, Pa.
77342	Potter and Brumfield, Div. of American Machine/Foundry	Princeton, Ind.
77630	Radio Condenser Co.	Camden, N.J.
77638	Radio Receptor Co., Inc.	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
77969	Rubbercraft Corp. of Calif.	Torrance, Calif.
78189	Shakeproof, Div. of Illinois Tool Works	Elgin, Illinois
78283	Signal Indicator Corp.	New York, N.Y.
78790	Struthers-Dunn, Inc.	Pitman, N.J.
78452	Thompson-Bremer and Co.	Chicago, Illinois
78471	Tilley Manufacturing Co.	San Francisco, Calif.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	Pasadena, Calif.
78947	Uclinite Co.	Newtonville, Mass.
79142	Weeder Prod, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Illinois
79727	Continental-Wirt Elect. Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
8003	Mepco, Div. of Sessions Clock Company	Morristown, N.J.
80170	Schnitzer Alloy Products	Elizabeth, N.J.
80130	Times Facsimile Corp.	New York, N.Y.
80131	Electronic Industries Assoc. Any brand tube meeting EIA standards.	Washington D.C.
80207	Unimax Switch, Div. of W L Maxson Corp.	Wallingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Illinois
80294	Bourns Laboratories, Inc.	Riverside, Calif.
8041	Acro, Div. Robershaw Fulton Controls Co.	Columbus, Ohio
80486	All Star Products, Inc.	Defiance, Ohio
80509	Avery Adhesive Label Corp.	Monrovia, Calif.
80583	Hammerlund Co., Inc.	New York, N.Y.
80640	Stevens, Arnold Co., Inc.	Boston, Mass.
81030	International Instruments, Inc.	New Haven, Conn.
81073	Grayhill Co.	LaGrange, Illinois
81095	Triad Transformer Corp.	Venice, Calif.
81312	Winchester Electronics Co,	Norwalk, Conn.
81349	Military Specifications	
81415	Wilkor Products, Inc.	Cleveland, Ohio
81453	Raytheon Mfg. Co., Industrial Components Div, Industrial Tube Oper.	Newton, Mass.
81483	International Rectifier Corp.	El Segundo, Calif.
81541	The Alpha Products Co.	Cambridge, Mass.
81860	Barry Controls, Inc.	Watertown, Mass.
82042	Carter Parts Co.	Skokie, Illinois
82142	Jeffers Electronics, Div. of Speer Carbon Co.	DuBois, Pa.
82170	Allen B. DuMont Labs, Inc.	Clifton, N.J.
82209	Maguire Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod., Electronic Tube Div.	Emporium, Pa.
82376	Astron Company	E. Newark, N.J.
82389	Switchcraft, Inc.	Orange, Illinois
82647	Metals and Controls, Inc., Div. Texas Instruments, Spencer Products	Attleboro, Mass.
82866	Research Products Corp.	Madison, Wisc.
82877	Rotron Mfg. Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Calif.
83053	Western Washer Mfr. Co.	Los Angeles, California
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing	Peterborough, N.H.
83125	Pyramid Electric Co.	Darlington, S.C.
83148	Electro Cords Co.	Los Angeles, Calif.
83186	Victory Engineering Corp.	Springfield, N.J.
83298	Bendix Corp/Red Bank Div.	Red Bank, N.J.
83315	Hubbell Corp.	Mundelein, Illinois
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83385	Central Screw Co.	Chicago, Illinois
83501	Gavitt Wire and Cable Co., Div. Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp., Electronic Tube Div.	Plainfield, N.J.

Code No.	Manufacturer	Address
83740	Eveready Battery	New York, N.Y.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
84171	Arco Electronics, Inc.	New York, N.Y.
84396	A.J. Glesener Co., Inc.	San Francisco, Calif.
84411	Good All Electric Mfg. Co.	Ogallala, Neb.
84970	Sorkes Torzion, Inc.	Bloamington, Ind.
85454	Boonton Molding Co.	Boonton, N.J.
85474	R.M. Bracamonte and Co.	San Francisco, Calif.
85660	Koiled Kords, Inc.	New Haven, Conn.
85911	Seamless Rubber Co.	Chicago, Illinois
86197	Clifton Precision Products	Clifton Heights, Pa.
86579	Precision Rubber Products Corp.	Dayton, Ohio
86684	Radio Corp. of America, RCA Electron Tube Div.	Harrison, N.J.
87216	Philco Corp. (Lansing Div.)	Lansing, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco
87664	Van Waters and Rogers, Inc.	Seattle, Wash.
87930	Tower Mfg. Co.	Providence, R.I.
88140	Cutler-Hammer, Inc.	Lincoln, Illinois
88220	Gould-National Batteries, Inc.	St. Paul, Minn.
88698	General Mills, Inc.	Buffalo, N.Y.
8923	Graybar Electric Co.	Oakland, Calif.
89462	Waldes Kohinoar, Inc.	Cambridge, Mass.
89473	General Electric Distributing Corp.	Schenectady, N.Y.
89636	Carter Parts Div. of Economy Baker Co.	Chicago, Illinois
89865	United Transformer Co.	Chicago, Illinois
90179	U.S. Rubber Co., Mechanical Goods Div.	Passaic, N.J.
90970	Bearing Engineering Co.	San Francisco, Calif.
91260	Connor Spring Mfg. Co.	San Francisco, Calif.
91345	Miller Dial and Nameplate Co.	El Monte, Calif.
91418	Radio Materials Co.	Chicago, Illinois
91506	Augat Brothers', Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Neb.
91662	Elco Corp.	Philadelphia
91737	Gremar Mfg Co., Inc.	Wakefield, Mass.
91929	Minneapolis-Honeywell Regulator Co., Microswitch Div.	Freeport, Illinois
91961	Nahm-Bros. Spring Co.	Oakland, Calif.
92180	Tru-Connector Corp.	Peabody, Mass.
92196	Universal Metal Prod., Inc.	Bassett Puente, Calif.
92367	Elgeel Optical Co., Inc.	Rochester, N.Y.
92607	Tinsulite Insulated Wire Co.	Tarrytown, N.Y.
93332	Sylvania Electric Prod, Inc. Semiconductor Div.	Woburn, Mass.
93369	Robbins and Myers, Inc.	New York, N.Y.
93410	Stevens Mfg. Co., Inc.	Mansfield, Ohio
93788	Howard J. Smith, Inc.	Port Minmouth, N J.
93979	G.V. Controls	Livingston, N.J.
93983	Insuline-Van Norman Ind., Inc. Electronic Division	Manchester, N.H.
94037	General Cable Corp.	Bayonne, N.J.
94 44	Raytheon Mfg. Co., Industrial Comp. Div. Rec. Tube Div.	Quincy, Mass.
94145	Raytheon Mfg. Co., Semiconductor Div, Calif. St. Plt	Newton, Mass.
94148	Scientific Radio Products	Loveland, Colo.
94154	Tung-Sol Electric, Inc.	Newark, N.J.
94197	Curtis-Wright Corp. Electronics Div.	E. Paterson, N.J.
94222	Southco, Div. S. Chester Corp.	Lester, Pa.
943.0	Tru Ohm Prod., Div. Model Engineering and Mfg. Co.	Chicago, Illinois
94330	Wire Cloth Products, Inc.	Chicago, Illinois
94682	Worcester Pressed Alum. Corp.	Worcester, Mass.
95023	Philbrick Researchers, Inc.	Boston, Mass.
95236	Allies Products Corp.	Chicago, Illinois
95238	Continental Connector Corp.	Woodside, N.Y.
9526 3	Leecraft Mfg. Co., Inc.	New York, N.Y.
95264	Lerco Electronics, Inc.	Burbank, Calif.
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitraman, Inc.	Bridgeport, Conn.
95348	Gordos Corp.	Bloomfield, N.J.
95354	Methode Mfg. Co.	Chicago, Illinois
95372	Doge Electric Co., Inc.	Franklin, Ind.
95987	Weckesser Co.	Chicago, Illinois
96067	Huggins Laboratories	Sunnyvale, Calif.
96095	Hi-Q Div. of Aerovox	Olean, N.Y.
96256	Thordarson-Meisner, Div. Maguire Industries, Inc.	Mt. Carmel, Ill.
96296	Solar Manufacturing Co.	Los Angeles, Calif.
96330	Carlton Screw Co.	Chicago, Illinois
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Calif.
97464	Industrial Retaining Ring Co.	Irvington, N.J
97539	Automatic and Precision Mfg.	Yonkers, N.Y.
97966	CBS Electronics Div. C.B.S., Inc.	Danvers, Mass.
97979	Reon Resistor Corp.	Yonkers, N.Y.
98141	Axel Brothers, Inc.	Jamaica, N.Y.
98159	Rubber Teck, Inc.	Gurdena, Calif.
98220	Francis L. Mosley	Pasadena, Calif.
98278	Microdot, Inc.	S. Pasadena, Calif.
98291	Sealectro Corp.	Mamaroneck, N.Y.
98405	Corad Corp.	Redwood City, Calif.
98731	Genera- Mills	Minneapolis, Minn.
9882	North Hills Electric Co.	Mineola, N.Y.
98925	Clevite Transitor Prod. Div. Clevite Corp.	Waltham, Mass.
98978	International Electronic Research Corp.	Burbank, Calif.
99109	Columbia Technical Corp	New York, N.Y.
9933	Varian Associates	Palo Alto, Calif.
99515	Marshall Industries, Electron Products Division	Pasadena, Calif.
99707	Control Switch Div, Controls Co. of America	El Segundo, Calif
99800	Delevan Electronics Corp.	E. Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99934	Renbrandt, Inc.	Boston, Mass.
99942	Hoffman Semiconductor Div. of Hoffman Electronics Corp.	Evanston, Illinois
99957	Technology Instrument Corp. of California	Newbury Park, Calif.

PART	DESCRIPTION	EXACT NO	MFG
C0101	CAPACITOR, 2000 MFD 15 VOLT	2900054	37942
C0102	CAPACITOR, 1000 PF DISCAP	2830000	91418
C0105	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0120	CAPACITOR, 2500MFD 35V	2900034	853
C0121	CAPACITOR, 100PF MICA	2810537	853
C0125	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0130	CAPACITOR, 47PF MICA	2810532	853
C0135	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0140	CAPACITOR, 2500MFD 35V	2900034	853
C0141	CAPACITOR, 5000 PF DISCAP	2830011	91418
C0155	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0160	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0175	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0176	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0205	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0215	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0235	CAPACITOR, 1000 PF DISCAP	2830000	91418
C0240	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0241	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0243	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0265	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0266	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0275	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0276	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0300	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0301	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0311	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0345	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0360	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0391	CAPACITOR, 0,47MFD 75V	2900050	56289
C0405	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0410	CAPACITOR, SELECTED VALUE		
C0418	CAPACITOR, 39PF MICA	2810531	853
C0420	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0421	CAPACITOR, 5,5-18PF TRIM	2810011	72982
C0422	CAPACITOR, 7PF MICA	2810536	853
C0423	CAPACITOR, 47PF MICA	2810532	853
C0424	CAPACITOR, TIMING SET	2950004	10597
C0425	CAPACITOR, SELECTED VALUE		
C0426	CAPACITOR, 0,05 MFD 50 VOLT	2900052	10597
C0428	CAPACITOR, 5,5-18PF TRIM	2810011	72982
C0435	CAPACITOR, 18PF MICA	2810552	14655
C0445	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0446	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0447	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0448	CAPACITOR, 5000 PF DISCAP	2830011	91418
C0451	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0452	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0456	CAPACITOR, 5,5-18PF TRIM	2810011	72982
C0457	CAPACITOR, 18PF MICA	2810552	14655
C0460	CAPACITOR, 7PF MICA	2810536	853
C0465	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0466	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0471	CAPACITOR, 39PF MICA	2810531	853
C0475	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0476	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0477	CAPACITOR, 10PF MICA	2810529	853
C0478	CAPACITOR, 10PF MICA	2810529	853
C0481	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0482	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0483	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0486	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0487	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0488	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0500	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0501	CAPACITOR, 220PF MICA	2810555	853
C0505	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0510	CAPACITOR, 82PF MICA	2810533	853
C0511	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0512	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0515	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0516	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0527	CAPACITOR, 47PF MICA	2810532	853
C0609	CAPACITOR, 82PF MICA	2810533	853
C0610	CAPACITOR, 150PF MICA	2810557	853
C0611	CAPACITOR, 82PF MICA	2810533	853
C0612	CAPACITOR, 82PF MICA	2810533	853
C0700	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0701	CAPACITOR, 47PF MICA	2810532	853
C0707	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0715	CAPACITOR, 0,01 UF DISCAP	2830005	91418
C0720	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0725	CAPACITOR, 0,01 UF DISCAP	2830005	91418
C0726	CAPACITOR, 5,5-18PF TRIM	2810011	72982
C0727	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0731	CAPACITOR, 1000 PF DISCAP	2830002	91418
C0735	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0737	CAPACITOR, 1000 PF DISCAP	2830002	91418
C0740	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0741	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0745	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0746	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0751	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0756	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0760	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0761	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0763	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0768	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0780	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0781	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0785	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0787	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0791	CAPACITOR, 1000 PF DISCAP	2830002	91418
C0795	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0797	CAPACITOR, 1000 PF DISCAP	2830002	91418
C0800	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0801	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0805	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0806	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0811	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0816	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0817	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0818	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0830	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0831	CAPACITOR, 100PF MICA	2810537	853
C0835	CAPACITOR, 3PF MICA	2810500	853
C0837	CAPACITOR, 5000 PF DISCAP	2830011	91418
C0840	CAPACITOR, 5000 PF DISCAP	2830011	91418
C0845	CAPACITOR, 5000 PF DISCAP	2830011	91418
C0846	CAPACITOR, 1000 PF DISCAP	2830002	91418
C0850	CAPACITOR, 82PF MICA	2810533	853
C0862	CAPACITOR, 7PF MICA	2810536	853
C0865	CAPACITOR, 150PF MICA	2810557	853
C0900	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0901	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0940	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0941	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0950	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0960	CAPACITOR, 5,5-18PF TRIM	2810011	72982
C0961	CAPACITOR, 47PF MICA	2810532	853
C0963	CAPACITOR, TIMING SET	2950004	10597
C0964	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0965	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0966	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0967	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C0968	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C0975	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C1000	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C1001	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C1010	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C1020	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C1035	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C1070	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C1071	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C1072	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C1100	CAPACITOR, 5,5-18PF TRIM	2810011	72982
C1102	CAPACITOR, 22PF MICA	2810530	853
C1120	CAPACITOR, 5000 PF DISCAP	2830011	91418
C1135	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C1140	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C1143	CAPACITOR, 6,8 MFD 35 VOLT	2900043	100002
C1151	CAPACITOR, 270PF MICA	2810540	853
C1152	CAPACITOR, 220PF MICA	2810555	853
C1153	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C1200	CAPACITOR, 68PF MICA	2810523	853
C1222	CAPACITOR, 0,05 UF DISCAP	2830010	91418
C1211	CAPACITOR, 0,05 UF DISCAP	2830010	91418
D0100	DIODE, 1N4001	1524001	1295
D0105	DIODE, 1N4001	1524001	1295
D0106	DIODE, 1N4001	1524001	1295
D0120	RECTIFIER BRIDGE, MDA920A-3	1520922	4713
D0125	DIODE, 1N4001	1524001	1295
D0135	DIODE, 1N4001	1524001	1295
D0160	DIODE, 1N914	1520914	7910
D0161	DIODE, 1N4001	1524001	1295
D0165	DIODE, 1N757	1520757	1295
D0175	DIODE, 1N4001	1524001	1295
D0340	DIODE, CD1541	1521541	14655
D0341	DIODE, HOT CARRIER	1522835	10597
D0342	DIODE, HOT CARRIER	1522835	10597
D0343	DIODE, CD1541	1521541	14655
D0344	DIODE, HOT CARRIER	1522835	10597
D0345	DIODE, CD1541	1521541	14655
D0346	DIODE, HOT CARRIER	1522835	10597
D0347	DIODE, CD1541	1521541	14655
D0355	DIODE, CD1541	1521541	14655
D0356	DIODE, HOT CARRIER	1522835	10597
D0357	DIODE, HOT CARRIER	1522835	10597
D0358	DIODE, CD1541	1521541	14655
D0359	DIODE, CD1541	1521541	14655
D0360	DIODE, HOT CARRIER	1522835	10597
D0361	DIODE, HOT CARRIER	1522835	10597
D0362	DIODE, CD1541	1521541	14655
D0387	DIODE, 1N914	1520914	7910
D0388	DIODE, 1N914	1520914	7910
D0410	DIODE, HOT CARRIER	1522835	10597
D0411	DIODE, CD1541	1521541	14655
D0412	DIODE, CD1541	1521541	14655
D0413	DIODE, HOT CARRIER	1522835	10597
D0425	DIODE, HOT CARRIER	1522835	10597
D0426	DIODE, CD1541	1521541	14655
D0427	DIODE, CD1541	1521541	14655
D0428	DIODE, HOT CARRIER	1522835	10597
D0451	TO		
D0454	DIODE, 1N914	1520914	7910
D0460	TO		
D0463	DIODE, HOT CARRIER	1522835	10597
D0464	DIODE, HOT CARRIER	1522835	10597
D0465	DIODE, 1N914	1520914	7910
D0466	DIODE, 1N914	1520914	7910
D0467	DIODE, HOT CARRIER	1522835	10597
D0468	DIODE, 1N914	1520914	7910
D0469	DIODE, 1N914	1520914	7910
D0470	DIODE, HOT CARRIER	1522835	10597
D0471	DIODE, HOT CARRIER	1522835	10597
D0473	DIODE, HOT CARRIER	1522835	10597
D0474	DIODE, HOT CARRIER	1522835	10597
D0475	DIODE, 1N914	1520914	7910
D0476	DIODE, 1N914	1520914	7910
D0477	DIODE, HOT CARRIER	1522835	10597
D0478	DIODE, HOT CARRIER	1522835	10597
D0481	DIODE, 1N914	1520914	7910
D0482	DIODE, 1N914	1520914	7910
D0500	TO		
D0503	DIODE, 1N914	1520914	7910
D0510	DIODE, 1N914	1520914	7910
D0511	DIODE, HOT CARRIER	1522835	10597
D0513	DIODE, HOT CARRIER	1522835	10597
D0516	DIODE, HOT CARRIER	1522835	10597
D0517	DIODE, HOT CARRIER	1522835	10597
D0518	DIODE, HOT CARRIER	1522835	10597
D0519	DIODE, 1N914	1520914	7910
D0522	DIODE, HOT CARRIER	1522835	10597
D0521	DIODE, HOT CARRIER	1522835	10597

PART	DESCRIPTION	EXACT NO	MFG
D0522	DIODE, 1N914	1520914	7910
D0523	DIODE, 1N914	1520914	7910
D0524	DIODE, HOT CARRIER	1522835	10597
D0525	DIODE, 1N914	1520914	7910
D0526	DIODE, HOT CARRIER	1522835	10597
D0527	DIODE, 1N914	1520914	7910
D0528	DIODE, 1N914	1520914	7910
D0529	DIODE, 1N914	1520914	7910
D0530	DIODE, HOT CARRIER	1522835	10597
D0531	DIODE, HOT CARRIER	1522835	10597
D0600	DIODES, MATCHED 2835	1532835	10597
D0604	DIODES, MATCHED 2835	1532835	10597
D0608	DIODES, MATCHED 2835	1532835	10597
D0612	DIODES, MATCHED 2835	1532835	10597
D0740	DIODE, 1N914	1520914	7910
D0741	DIODE, 1N914	1520914	7910
D0742	DIODE, 1N914	1520914	7910
D0745	DIODE, 1N914	1520914	7910
D0746	DIODE, 1N914	1520914	7910
D0747	DIODE, 1N914	1520914	7910
D0751	DIODE, 1N753A	1520753	1295
D0756	DIODE, 1N753A	1520753	1295
D0800	DIODE, 1N914	1520914	7910
D0801	DIODE, 1N914	1520914	7910
D0802	DIODE, 1N914	1520914	7910
D0803	DIODE, 1N914	1520914	7910
D0804	DIODE, 1N914	1520914	7910
D0805	DIODE, 1N914	1520914	7910
D0806	DIODE, 1N914	1520914	7910
D0807	DIODE, 1N914	1520914	7910
D0835	DIODE, CD1541	1521541	14655
D0836	DIODE, CD1541	1521541	14655
D0837	DIODE, 1N914	1520914	7910
D0838	DIODE, 1N751A	1520751	75042
D0845	DIODE, 1N753A	1520753	1295
D0850	DIODE, 1N914	1520914	7910
D0851	DIODE, 1N914	1520914	7910
D0852	DIODE, 1N914	1520914	7910
D0853	DIODE, HOT CARRIER	1522835	10597
D0854	DIODE, 1N914	1520914	7910
D0855	DIODE, HOT CARRIER	1522835	10597
D0857	DIODE, 1N757	1520757	1295
D0859	DIODE, 1N914	1520914	7910
D0862	DIODE, 1N704A	1520704	1295
D0950	DIODE, CD1541	1521541	14655
D0951	DIODE, HOT CARRIER	1522835	10597
D0952	DIODE, HOT CARRIER	1522835	10597
D0953	DIODES, MATCHED CD1541	1530015	10597
D0954	DIODE, HOT CARRIER	1522835	10597
D0955	DIODE, CD1541	1521541	14655
D0960	DIODE, HOT CARRIER	1522835	10597
D0961	DIODE, HOT CARRIER	1522835	10597
D0962	DIODE, HOT CARRIER	1522835	10597
D0964	DIODE, 1N748	1520748	1295
D0965	DIODE, HOT CARRIER	1522835	10597
D0970	DIODE, HOT CARRIER	1522835	10597
D0971	DIODES, MATCHED CD1541	1530015	10597
D0972	DIODE, HOT CARRIER	1522835	10597
D0973	DIODE, CD1541	1521541	14655
D0974	DIODE, HOT CARRIER	1522835	10597
D0975	DIODE, HOT CARRIER	1522835	10597
D1010	DIODE, HOT CARRIER	1522835	10597
D1011	DIODE, CD1541	1521541	14655
D1012	DIODE, HOT CARRIER	1522835	10597
D1013	DIODE, CD1541	1521541	14655
D1014	DIODE, CD1541	1521541	14655
D1015	DIODE, HOT CARRIER	1522835	10597
D1040	DIODE, HOT CARRIER	1522835	10597
D1041	DIODE, CD1541	1521541	14655
D1100	DIODE, HOT CARRIER	1522835	10597
D1101	DIODE, HOT CARRIER	1522835	10597
D1110	DIODE, HOT CARRIER	1522835	10597
D1111	DIODE, 1N914	1520914	7910
D1112	DIODE, CD1541	1521541	14655
D1113	DIODE, HOT CARRIER	1522835	10597
D1114	DIODE, HOT CARRIER	1522835	10597
D1115	DIODE, CD1541	1521541	14655
D1116	DIODE, CD1541	1521541	14655
D1117	DIODE, 1N914	1520914	7910
D1120	DIODE, HOT CARRIER	1522835	10597
D1121	DIODE, HOT CARRIER	1522835	10597
D1135	DIODE, 1N914	1520914	7910
D1136	DIODE, 1N914	1520914	7910
D1137	DIODE, 1N914	1520914	7910
D1138	DIODE, HOT CARRIER	1522835	10597
D1139	DIODE, 1N914	1520914	7910
D1140	DIODE, HOT CARRIER	1522835	10597
D1141	DIODE, CD1541	1521541	14655
D1142	DIODE, CD1541	1521541	14655
D1143	DIODE, CD1541	1521541	14655
D1144	DIODE, 1N914	1520914	7910
D1145	DIODE, HOT CARRIER	1522835	10597
D1146	DIODE, CD1541	1521541	14655
D1147	DIODE, 1N914	1520914	7910
D1148	DIODE, HOT CARRIER	1522835	10597
D1149	DIODE, CD1541	1521541	14655
D1150	TO		
D1153	DIODE, 1N914	1520914	7910
D1160	DIODE, HOT CARRIER	1522835	10597
D1161	DIODE, HOT CARRIER	1522835	10597
D1162	DIODE, 1N914	1520914	7910
D1163	DIODE, CD1541	1521541	14655
D1164	DIODE, CD1541	1521541	14655
D1165	DIODE, CD1541	1521541	14655
D1166	DIODE, 1N914	1520914	7910
D1167	DIODE, HOT CARRIER	1522835	10597
D1168	DIODE, 1N914	1520914	7910
D1170	DIODE, 1N914	1520914	7910
D1171	DIODE, 1N914	1520914	7910
D1172	DIODE, HOT CARRIER	1522835	10597
D1175	DIODE, 1N914	1520914	7910
D1176	DIODE, 1N914	1520914	7910
D1177	DIODE, HOT CARRIER	1522835	10597
D1178	TO		
D1181	DIODE, HOT CARRIER	1522835	10597
D1182	DIODE, 1N914	1520914	7910
D1183	DIODE, 1N914	1520914	7910
D1190	DIODE, HOT CARRIER	1522835	10597
D1191	DIODE, 1N914	1520914	7910
D1192	DIODE, HOT CARRIER	1522835	10597
D1193	DIODE, 1N914	1520914	7910
D1200	DIODE, 1N914	1520914	7910
D1210	DIODE, 1N914	1520914	7910
I0100	LED, MLED650	1520002	4713
J0100	BINDING POST, BLACK	3550536	10597
J0101	BINDING POST, WHITE	3550535	10597
J0240	CONNECTOR, BNC	1310047	91836
J0260	CONNECTOR, BNC	1310047	91836
J0452	CONNECTOR, BNC	1310047	91836
J0490	CONNECTOR, BNC	1310047	91836
J0500	CONNECTOR, BNC	1310047	91836
J0800	CONNECTOR, BNC	1310047	91836
J0840	CONNECTOR, BNC	1310047	91836
J0961	CONNECTOR, PC SOCKET	1310068	10597
J0963	CONNECTOR, PC SOCKET	1310068	10597
J1135	CONNECTOR, BNC	1310047	91836
J1157	CONNECTOR, BNC	1310047	91836
J1210	CONNECTOR, BNC	1310047	91836
K0494	RELAY, SPST REED 5 VOLT	2600328	10597
K0510	RELAY, SPST REED 5 VOLT	2600328	10597
L0140	BEAD, FERRITE G303	1140034	1121
L0440	BEAD, FERRITE G303	1140034	1121
L0460	BEAD, FERRITE G303	1140034	1121
L0461	BEAD, FERRITE G303	1140034	1121
L0465	BEAD, FERRITE G303	1140034	1121
L0470	BEAD, FERRITE G303	1140034	1121
L0800	BEAD, FERRITE G303	1140034	1121
L0835	BEAD, FERRITE G303	1140034	1121
L0980	BEAD, FERRITE G303	1140034	1121
L0981	BEAD, FERRITE G303	1140034	1121
L1100	BEAD, FERRITE G303	1140034	1121
L1101	BEAD, FERRITE G303	1140034	1121
L1102	BEAD, FERRITE G303	1140034	1121
L1130	BEAD, FERRITE G303	1140034	1121
P0961	CONNECTOR, PC PIN	1310069	10597
P0963	CONNECTOR, PC PIN	1310069	10597
Q0100	INTEGRATED CIRCUIT, UA723C	1580042	1295
Q0105	TRANSISTOR, 2N4918	1564918	4713
Q0120	INTEGRATED CIRCUIT, UA723C	1580042	1295
Q0125	TRANSISTOR, MJE3055	1563055	5277
Q0130	INTEGRATED CIRCUIT, UA723C	1580042	1295
Q0135	TRANSISTOR, 2N4921	1564921	4713
Q0140	TRANSISTOR, 2N2219	1562219	1295
Q0145	TRANSISTOR, 2N2955	1562955	1295
Q0150	TRANSISTOR, 2N4121	1564121	7263
Q0155	TRANSISTOR, 2N4121	1564121	7263
Q0160	TRANSISTOR, 2N2219	1562219	1295
Q0165	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q0170	TRANSISTOR, 2N2905	1562905	1295
Q0175	TRANSISTOR, 2N4918	1564918	4713
Q0180	TRANSISTOR, 2N2219	1562219	1295
Q0190	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q0200	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q0205	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q0206	TRANSISTOR, MPS3646	1563646	4713
Q0210	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q0215	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q0216	TRANSISTOR, 2N4121	1564121	7263
Q0220	INTEGRATED CIRCUIT, SN76502N	1580030	1295
Q0230	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q0235	TRANSISTOR, 2N2905	1562905	1295
Q0240	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q0260	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q0265	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q0270	TRANSISTOR, 2N5245	1565245	1295
Q0275	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q0280	TRANSISTOR, 2N5462	1565462	4713
Q0300	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q0310	TRANSISTOR, 2N2219	1562219	1295
Q0340	TRANSISTOR, UC2138	1562138	61637
Q0345	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q0350	TRANSISTOR, 2N4250	1564250	7263
Q0355	TRANSISTOR, UC2139	1562138	61637
Q0360	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q0365	TRANSISTOR, 2N2219	1562219	1295
Q0370	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q0385	TRANSISTOR, 2N2219	1562219	1295
Q0390	TRANSISTOR, 2N2905	1562905	1295
Q0400	TRANSISTOR, UC2138	1562138	61637
Q0405	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q0410	TRANSISTOR, UC400	1562400	17856
Q0415	TRANSISTOR, UC2138	1562138	61637
Q0420	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q0425	TRANSISTOR, 2N4416	1564416	4713
Q0430	TRANSISTOR, 2N2905	1562905	1295
Q0435	TRANSISTOR, DN991	1560991	10597
Q0440	TRANSISTORS, MATCHED MPS3563	1573563	10597
Q0445	TRANSISTOR, MATCHED 2N3866	1573866	10597
Q0460	TRANSISTORS, MATCHED TIS87	1572087	10597
Q0465	TRANSISTOR, 2N2219	1562219	1295
Q0470	TRANSISTOR, 2N4258	1564258	7263
Q0475	TRANSISTOR, 2N4258	1564258	7263
Q0490	TRANSISTOR, MPS3563	1563563	4713
Q0495	TRANSISTOR, 2N4121	1564121	7263
Q0500	INTEGRATED CIRCUIT, MC1035	1581035	4713
Q0510	INTEGRATED CIRCUIT, MC10109	1580109	4713
Q0515	TRANSISTOR, 2N2219	1562219	1295
Q0520	TRANSISTOR, 2N4258	1564258	7263
Q0525	TRANSISTOR, 2N4258	1564258	7263
Q0700	INTEGRATED CIRCUIT, CA3046	1580043	1295
Q0720	TRANSISTOR, 2N4258	1564258	7263
Q0725	TRANSISTOR, MPS3563	1563563	4713
Q0730	TRANSISTOR, 2N2905	1562905	1295
Q0735	TRANSISTOR, 2N2219	1562219	1295

PART	DESCRIPTION	EXACT NO	MFG
Q0740	TRANSISTOR, MPS3563	1563563	4713
Q0745	TRANSISTOR, 2N4258	1564258	7263
Q0750	TRANSISTOR, MPS3563	1563563	4713
Q0755	TRANSISTOR, 2N4258	1564258	7263
Q0760	INTEGRATED CIRCUIT, CA3046	1580043	1295
Q0780	TRANSISTOR, 2N4258	1564258	7263
Q0785	TRANSISTOR, MPS3646	1563646	4713
Q0790	TRANSISTOR, 2N5160	1565160	4713
Q0795	TRANSISTOR, 2N3866	1563866	4713
Q0800	TRANSISTOR, TIS87	1560087	1295
Q0805	TRANSISTOR, 2N4121	1564121	7263
Q0810	TRANSISTOR, 2N2219	1562219	1295
Q0815	TRANSISTOR, 2N2905	1562905	1295
Q0830	TRANSISTORS, MATCHED 2N4258	1574258	10597
Q0835	TRANSISTOR, TIS87	1560087	1295
Q0840	TRANSISTOR, MPS3563	1563563	4713
Q0845	TRANSISTOR, 2N4258	1564258	7263
Q0850	TRANSISTOR, TIS87	1560087	1295
Q0860	TRANSISTOR, TIS87	1560087	1295
Q0865	TRANSISTOR, MPS3646	1563646	4713
Q0900	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q0910	TRANSISTOR, 2N2905	1562905	1295
Q0940	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q0945	TRANSISTOR, 2N5485	1565485	4713
Q0950	TRANSISTOR, UC2138	1562138	61637
Q0955	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q0960	TRANSISTOR, UC400	1560400	17856
Q0962	TRANSISTOR, 2N4258	1564258	7263
Q0963	TRANSISTOR, 2N2219	1562219	1295
Q0965	TRANSISTOR, ON991	1560991	10597
Q0975	TRANSISTOR, MATCHED 2N3866	1573866	10597
Q0980	TRANSISTORS, MATCHED TIS87	1570087	10597
Q1000	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q1005	TRANSISTOR, 2N4250	1564250	7263
Q1010	TRANSISTOR, UC2138	1562138	61637
Q1015	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q1020	TRANSISTOR, 2N5485	1565485	4713
Q1025	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q1026	TRANSISTOR, 2N4258	1564258	7263
Q1030	TRANSISTOR, UC2138	1562138	61637
Q1035	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q1040	TRANSISTOR, 2N5485	1565485	4713
Q1050	TRANSISTOR, 2N2219	1562219	1295
Q1070	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q1100	TRANSISTORS, MATCHED TIS87	1570087	10597
Q1110	TRANSISTOR, 2N4258	1564258	7263
Q1125	TRANSISTOR, MPS3646	1563646	4713
Q1130	TRANSISTOR, MPS3563	1563563	4713
Q1135	TRANSISTOR, MPS3646	1563646	4713
Q1140	TRANSISTOR, 2N4258	1564258	7263
Q1150	INTEGRATED CIRCUIT, MC1004	1581004	4713
Q1160	TRANSISTOR, 2N4258	1564258	7263
Q1170	TRANSISTOR, 2N4258	1564258	7263
Q1200	TRANSISTOR, 2N2219	1562219	1295
Q1210	TRANSISTOR, 2N2905	1562905	1295
R0100	RESISTOR, 750 OHM 1/4W 1% METAL FILM	3137500	7115
R0101	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R0102	RESISTOR, 2210 OHM 1/4W 1% METAL FILM	3132211	7115
R0103	RESISTOR, 56 OHM 1/4W 5% CARBON	3070560	1121
R0105	RESISTOR, 2.0 OHM 1/2W 5% CARBON	3010020	1121
R0120	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222	1121
R0125	RESISTOR, 0.5 OHM WIREWOUND	3080005	75042
R0126	RESISTOR, 7870 OHM 1/4W 1% METAL FILM	3137871	7115
R0127	POTENTIOMETER, 1K OHM TRIM	3110147	71450
R0128	RESISTOR, 3010 OHM 1/4W 1% METAL FILM	3133011	7115
R0130	RESISTOR, 1600 OHM 1/4W 5% CARBON	3070162	1121
R0131	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R0135	RESISTOR, 0.5 OHM WIREWOUND	3080005	75042
R0136	RESISTOR, 3320 OHM 1/4W 1% METAL FILM	3133321	7115
R0137	POTENTIOMETER, 1K OHM TRIM	3110147	71450
R0138	RESISTOR, 3010 OHM 1/4W 1% METAL FILM	3133011	7115
R0140	RESISTOR, 360 OHM 1/4W 5% CARBON	3070361	1121
R0141	RESISTOR, 5600 OHM 1/4W 5% CARBON	3070562	1121
R0142	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R0143	RESISTOR, 15K OHM 1/4W 5% CARBON	3070153	1121
R0145	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R0146	RESISTOR, 0.5 OHM WIREWOUND	3080005	75042
R0150	RESISTOR, 4990 OHM 1/4W 1% METAL FILM	3134991	7115
R0151	RESISTOR, 5600 OHM 1/4W 5% CARBON	3070562	1121
R0152	RESISTOR, 36500 OHM 1/4W 1% METAL FILM	3133652	7115
R0155	RESISTOR, 5600 OHM 1/4W 5% CARBON	3070562	1121
R0156	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R0157	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R0158	RESISTOR, 12700 OHM 1/4W 1% METAL FILM	3131272	7115
R0161	RESISTOR, 13K OHM 1/4W 5% CARBON	3070133	1121
R0162	RESISTOR, 34800 OHM 1/4W 1% METAL FILM	3133482	7115
R0165	RESISTOR, 15000 OHM 1/4W 1% METAL FILM	3131502	7115
R0166	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R0167	RESISTOR, 22100 OHM 1/4W 1% METAL FILM	3132212	7115
R0168	RESISTOR, 8250 OHM 1/4W 1% METAL FILM	3138251	7115
R0170	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R0171	RESISTOR, 10K OHM 1/4W 5% CARBON	3070103	1121
R0175	RESISTOR, 0.5 OHM WIREWOUND	3080005	75042
R0190	RESISTOR, 15K OHM 1/4W 5% CARBON	3070153	1121
R0191	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R0192	POTENTIOMETER, 10K OHM 20 TURN TRIM	3110114	19701
R0193	RESISTOR, 100 OHM 1/4W 1% METAL FILM	3131001	7115
R0200	POTENTIOMETER, 5K OHM 15T PC	3110084	19701
R0201	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R0202	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R0204	RESISTOR, 2300 OHM 1/4W 1% METAL FILM	3132001	7115
R0205	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R0206	RESISTOR, 220 OHM 1/4W 5% CARBON	3070221	1121
R0207	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R0209	RESISTOR, 2000 OHM 1/4W 1% METAL FILM	3132001	7115
R0210	POTENTIOMETER, 10K OHM TRIM	3110150	71450
R0211	RESISTOR, 10K OHM 1/4W 5% CARBON	3070103	1121
R0212	RESISTOR, 9100 OHM 1/4W 5% CARBON	3070912	1121
R0213	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R0214	RESISTOR, 2000 OHM 1/4W 1% METAL FILM	3132001	7115
R0215	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R0216	RESISTOR, 220 OHM 1/4W 5% CARBON	3070221	1121
R0219	RESISTOR, 2000 OHM 1/4W 1% METAL FILM	3132001	7115
R0222	RESISTOR, 30900 OHM 1/4W 1% METAL FILM	3133092	7115
R0223	RESISTOR, 15800 OHM 1/4W 1% METAL FILM	3131582	7115
R0230	POTENTIOMETER, 10K OHM TRIM	3110150	71450
R0231	RESISTOR, 7500 OHM 1/4W 1% METAL FILM	3137501	7115
R0232	RESISTOR, 4990 OHM 1/4W 1% METAL FILM	3134991	7115
R0235	RESISTOR, 620 OHM 1/4W 5% CARBON	3070621	1121
R0236	RESISTOR, 110K OHM 1/4W 1% METAL FILM	3131103	7115
R0237	RESISTOR, 5100 OHM 1/4W 5% CARBON	3070512	1121
R0238	POTENTIOMETER, 20K OHM PC TRIM	3110131	78488
R0240	RESISTOR, 49900 OHM 1/4W 1% METAL FILM	3134992	7115
R0241	RESISTOR, 49900 OHM 1/4W 1% METAL FILM	3134992	7115
R0242	RESISTOR, 100000K OHM 1/4W 5% CARBON	3070106	1121
R0243	POTENTIOMETER, 10K OHM TRIM	3110150	71450
R0245	RESISTOR, 22K OHM 1/4W 5% CARBON	3070223	1121
R0246	POTENTIOMETER, 10K OHM TRIM	3110150	71450
R0247	RESISTOR, 124K OHM 1/4W 1% METAL FILM	3131243	7115
R0248	RESISTOR, 100K OHM 1/4W 1% METAL FILM	3131003	7115
R0249	RESISTOR, 20000 OHM 1/4W 1% METAL FILM	3132002	7115
R0261	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R0262	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R0263	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R0265	POTENTIOMETER, 10K OHM TRIM	3110150	71450
R0266	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R0269	RESISTOR, 1000 OHM MATCHED PAIR	3121001	10597
R0275	POTENTIOMETER, 10K OHM TRIM	3110150	71450
R0276	RESISTOR, 1000 OHM MATCHED PAIR	3121001	10597
R0300	POTENTIOMETER, 10K OHM TRIM	3110150	71450
R0301	RESISTOR, 5100 OHM 1/4W 5% CARBON	3070512	1121
R0302	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R0304	RESISTOR, 71500 OHM 1/4W 1% METAL FILM	3137152	7115
R0305	POTENTIOMETER, 10K OHM TRIM	3110150	71450
R0306	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R0310	RESISTOR, 1300 OHM 1/4W 5% CARBON	3070132	1121
R0311	RESISTOR, 620 OHM 1/4W 5% CARBON	3070621	1121
R0312	CONCENTRIC SWITCH & POTENTIOMETER	2600313	71450
R0313	RESISTOR, SELECTED VALUE		
R0314	TO		
R0325	RESISTOR, 10Ω OHM 1/8W 1% METAL FILM	3181000	7115
R0326	CONCENTRIC SWITCH & POTENTIOMETER	2600313	71450
R0327	RESISTOR, SELECTED VALUE		
R0328	TO		
R0339	RESISTOR, 100 OHM 1/8W 1% METAL FILM	3181000	7115
R0340	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R0342	RESISTOR, 274K OHM 1/4W 1% METAL FILM	3132743	7115
R0343	POTENTIOMETER, 2K OHM PC TRIM	3110130	78488
R0344	RESISTOR, 274K OHM 1/4W 1% METAL FILM	3132743	7115
R0345	RESISTOR, 499 OHM 1/4W 1% METAL FILM	3134990	7115
R0346	RESISTOR, 4990 OHM 1/4W 1% METAL FILM	3134991	7115
R0347	RESISTOR, 49900 OHM 1/4W 1% METAL FILM	3134992	7115
R0348	RESISTOR, 499K OHM 1/4W 1% METAL FILM	3134993	7115
R0349	RESISTOR, 5000K OHM 1/2W 1% DEP, CARBON	3295004	75042
R0350	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R0355	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R0357	RESISTOR, 274K OHM 1/4W 1% METAL FILM	3132743	7115
R0358	POTENTIOMETER, 2K OHM PC TRIM	3110130	78488
R0359	RESISTOR, 274K OHM 1/4W 1% METAL FILM	3132743	7115
R0360	RESISTOR, 499 OHM 1/4W 1% METAL FILM	3134990	7115
R0361	RESISTOR, 4990 OHM 1/4W 1% METAL FILM	3134991	7115
R0362	RESISTOR, 49900 OHM 1/4W 1% METAL FILM	3134992	7115
R0363	RESISTOR, 499K OHM 1/4W 1% METAL FILM	3134993	7115
R0364	RESISTOR, 5000K OHM 1/2W 1% DEP, CARBON	3295004	75042
R0365	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R0370	POTENTIOMETER, 10K OHM MIN	3110327	71450
R0371	RESISTOR, 100K OHM 1/4W 1% METAL FILM	3131003	7115
R0372	RESISTOR, 7500 OHM 1/4W 5% CARBON	3070752	1121
R0373	RESISTOR, 8060 OHM 1/4W 1% METAL FILM	3138061	7115
R0375	RESISTOR, 560 OHM 1/4W 5% CARBON	3070561	1121
R0380	RESISTOR, 560 OHM 1/4W 5% CARBON	3070561	1121
R0385	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100	1121
R0386	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472	1121
R0387	RESISTOR, 22 OHM 1/4W 5% CARBON	3070220	1121
R0388	RESISTOR, 22 OHM 1/4W 5% CARBON	3070220	1121
R0390	RESISTOR, 2.0 OHM 1/2W 5% CARBON	3010020	1121
R0392	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472	1121
R0393	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100	1121
R0400	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R0401	RESISTOR, 22 OHM 1/4W 5% CARBON	3070220	1121
R0402	RESISTOR, 274K OHM 1/4W 1% METAL FILM	3132743	7115
R0403	POTENTIOMETER, 2K OHM PC TRIM	3110130	78488
R0404	RESISTOR, 274K OHM 1/4W 1% METAL FILM	3132743	7115
R0405	RESISTOR, 1000 OHM MATCHED PAIR	3121001	10597
R0406	RESISTOR, 10000 OHM MATCHED PAIR	3121002	10597
R0407	RESISTOR, 100K OHM MATCHED PAIR	3121003	10597
R0408	RESISTOR, 1000K OHM MATCHED PAIR	3121004	10597
R0409	RESISTOR, 10000K OHM MATCHED PAIR	3121005	10597
R0410	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R0415	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R0417	RESISTOR, 274K OHM 1/4W 1% METAL FILM	3132743	7115
R0418	POTENTIOMETER, 2K OHM PC TRIM	3110130	78488
R0419	RESISTOR, 274K OHM 1/4W 1% METAL FILM	3132743	7115
R0425	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R0430	RESISTOR, 3900 OHM 1/4W 5% CARBON	3070392	1121
R0431	RESISTOR, 270 OHM 1/4W 5% CARBON	3070271	1121
R0432	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472	1121
R0433	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222	1121
R0435	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510	1121
R0440	RESISTOR, 750 OHM 1/4W 5% CARBON	3070751	1121
R0441	RESISTOR, 150 OHM 1/4W 5% CARBON	3070151	1121
R0442	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R0444	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R0445	RESISTOR, 220 OHM 1/2W 5% CARBON	3010221	1121
R0450	RESISTOR, 750 OHM 1/4W 5% CARBON	3070751	1121
R0451	RESISTOR, 10K OHM 1/4W 5% CARBON	3070103	1121
R0452	RESISTOR, 10K OHM 1/4W 5% CARBON	3070103	1121
R0455	RESISTOR, 383 OHM 1/2W 1% METAL FILM	3103830	7115
R0458	RESISTOR, 576 OHM 1/4W 1% METAL FILM	3135760	7115
R0459	RESISTOR, 249 OHM 1/4W 1% METAL FILM	3132490	7115
R0460	RESISTOR, 49.9 OHM 1/4W 1% METAL FILM	3132499	7115
R0461	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R0462	RESISTOR, 2490 OHM 1/4W 1% METAL FILM	3132491	7115
R0463	RESISTOR, 2490 OHM 1/4W 1% METAL FILM	3132491	7115

PART	DESCRIPTION	EXACT NO	MFG
R0464	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R0465	RESISTOR, 1580 OHM 1/4W 1% METAL FILM	3131581	7115
R0466	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R0467	RESISTOR, 2740 OHM 1/4W 1% METAL FILM	3132741	7115
R0468	RESISTOR, 820 OHM 1/2W 5% CARBON	3010821	1121
R0468	RESISTOR, 680 OHM 1/2W 5% CARBON	3010681	1121
R0470	RESISTOR, 221 OHM 1/2W 1% METAL FILM	3102210	7115
R0471	RESISTOR, 3320 OHM 1/4W 1% METAL FILM	3133321	7115
R0472	RESISTOR, 820 OHM 1/2W 5% CARBON	3010821	1121
R0475	RESISTOR, 3320 OHM 1/4W 1% METAL FILM	3133321	7115
R0476	RESISTOR, 22 OHM 1/4W 5% CARBON	3072220	1121
R0477	RESISTOR, 39 OHM 1/4W 5% CARBON	3070390	1121
R0480	RESISTOR, 4700 OHM 1/4W 5% CARBON	3074472	1121
R0481	RESISTOR, 150 OHM 1/4W 5% CARBON	3070151	1121
R0485	RESISTOR, 4700 OHM 1/4W 5% CARBON	3074472	1121
R0486	RESISTOR, 150 OHM 1/4W 5% CARBON	3070151	1121
R0491	RESISTOR, 22 OHM 1/4W 5% CARBON	3072220	1121
R0494	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R0496	RESISTOR, 22 OHM 1/4W 5% CARBON	3072220	1121
R0497	RESISTOR, 470 OHM 1/4W 5% CARBON	3074471	1121
R0500	RESISTOR, 68 OHM 1/4W 5% CARBON	3073680	1121
R0501	RESISTOR, 68 OHM 1/4W 5% CARBON	3073680	1121
R0502	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R0503	POTENTIOMETER, 1 K OHM REVERSE LOG	3110332	12697
R0504	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R0505	RESISTOR, 4700 OHM 1/4W 5% CARBON	3074472	1121
R0506	RESISTOR, 10K OHM 1/4W 5% CARBON	3071103	1121
R0507	RESISTOR, 499 OHM 1/4W 1% METAL FILM	3134990	7115
R0508	RESISTOR, 523 OHM 1/4W 1% METAL FILM	3135230	7115
R0509	RESISTOR, 1500 OHM 1/4W 5% CARBON	3071152	1121
R0510	RESISTOR, 475 OHM 1/4W 1% METAL FILM	3134750	7115
R0511	RESISTOR, 383 OHM 1/4W 1% METAL FILM	3133830	7115
R0512	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R0513	RESISTOR, 365 OHM 1/4W 1% METAL FILM	3133650	7115
R0514	RESISTOR, 383 OHM 1/4W 1% METAL FILM	3133830	7115
R0515	RESISTOR, 475 OHM 1/4W 1% METAL FILM	3134750	7115
R0516	RESISTOR, 8200 OHM 1/4W 5% CARBON	3078822	1121
R0517	RESISTOR, 2000 OHM 1/4W 5% CARBON	3072022	1121
R0518	RESISTOR, 6800 OHM 1/4W 5% CARBON	3076822	1121
R0519	RESISTOR, 39 OHM 1/4W 5% CARBON	3073902	1121
R0520	RESISTOR, 249 OHM 1/2W 1% METAL FILM	3102490	7115
R0521	RESISTOR, 680 OHM 1/4W 5% CARBON	3076681	1121
R0522	RESISTOR, 330K OHM 1/4W 5% CARBON	3073334	1121
R0525	RESISTOR, 560 OHM 1/2W 5% CARBON	3010561	1121
R0526	RESISTOR, 2000 OHM 1/4W 5% CARBON	3072022	1121
R0604	RESISTOR, 49.9 OHM 1/4W 1% METAL FILM	3130499	7115
R0605	RESISTOR, 200 OHM 1/4W 1% METAL FILM	3132000	7115
R0606	RESISTOR, 100 OHM 1/4W 1% METAL FILM	3131000	7115
R0607	RESISTOR, 88.7 OHM 1/4W 1% METAL FILM	3130887	7115
R0608	RESISTOR, 47 OHM 1/4W 5% CARBON	3074700	1121
R0610	RESISTOR, 100 OHM 1/4W 1% METAL FILM	3131000	7115
R0615	POTENTIOMETER, 1K OHM TRIM	3110147	71450
R0616	POTENTIOMETER, 1K OHM TRIM	3110147	71450
R0617	RESISTOR, 75.0 OHM 1/4W 1% METAL FILM	3130750	7115
R0618	RESISTOR, 63.4 OHM 1/4W 1% METAL FILM	3130634	7115
R0619	RESISTOR, 10700 OHM 1/4W 1% METAL FILM	3131072	7115
R0620	RESISTOR, 232 OHM 1/4W 1% METAL FILM	3132320	7115
R0621	RESISTOR, 10700 OHM 1/4W 1% METAL FILM	3131072	7115
R0623	RESISTOR, 30100 OHM 1/4W 1% METAL FILM	3133012	7115
R0624	POTENTIOMETER, 100 OHM TRIM	3110141	71450
R0627	RESISTOR, 28.7 OHM 1/8W 1% METAL FILM	3180287	7115
R0628	RESISTOR, 30100 OHM 1/4W 1% METAL FILM	3133012	7115
R0631	POTENTIOMETER, 1K OHM TRIM	3110147	71450
R0636	POTENTIOMETER, 1K OHM TRIM	3110147	71450
R0637	RESISTOR, 28.7 OHM 1/8W 1% METAL FILM	3180287	7115
R0645	RESISTOR, 11300 OHM 1/4W 1% METAL FILM	3131132	7115
R0646	RESISTOR, 11300 OHM 1/4W 1% METAL FILM	3131132	7115
R0647	RESISTOR, 7150 OHM 1/4W 1% METAL FILM	3137151	7115
R0648	RESISTOR, 7150 OHM 1/4W 1% METAL FILM	3137151	7115
R0700	RESISTOR, 14300 OHM 1/4W 1% METAL FILM	3131432	7115
R0701	RESISTOR, 1000 OHM 1/4W 5% CARBON	3071102	1121
R0702	RESISTOR, 15 OHM 1/4W 5% CARBON	3071150	1121
R0703	RESISTOR, 20000 OHM 1/4W 1% METAL FILM	3132002	7115
R0704	RESISTOR, 20000 OHM 1/4W 1% METAL FILM	3132002	7115
R0725	RESISTOR, 1500 OHM 1/4W 1% METAL FILM	3131501	7115
R0726	RESISTOR, 200K OHM 1/4W 1% METAL FILM	3132003	7115
R0727	POTENTIOMETER, 10K OHM TRIM	3110152	71450
R0738	POTENTIOMETER, 250 OHM	3110145	71450
R0709	RESISTOR, 1370 OHM 1/4W 1% METAL FILM	3131371	7115
R0710	RESISTOR, 3010 OHM 1/4W 1% METAL FILM	3133011	7115
R0712	RESISTOR, 330 OHM 1/4W 5% CARBON	3073331	1121
R0715	RESISTOR, 1000 OHM 1/4W 5% CARBON	3071102	1121
R0720	RESISTOR, 51 OHM 1/4W 5% CARBON	3075510	1121
R0721	RESISTOR, 120 OHM 1/4W 5% CARBON	3071121	1121
R0722	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R0725	RESISTOR, 9310 OHM 1/4W 1% METAL FILM	3139311	7115
R0726	RESISTOR, 51 OHM 1/4W 5% CARBON	3075510	1121
R0727	RESISTOR, 160 OHM 1/4W 5% CARBON	3071161	1121
R0728	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R0730	RESISTOR, 4020 OHM 1/4W 1% METAL FILM	3134021	7115
R0731	RESISTOR, 51 OHM 1/4W 5% CARBON	3075510	1121
R0735	RESISTOR, 5490 OHM 1/4W 1% METAL FILM	3135491	7115
R0736	RESISTOR, 4020 OHM 1/4W 1% METAL FILM	3134021	7115
R0737	RESISTOR, 51 OHM 1/4W 5% CARBON	3075510	1121
R0740	RESISTOR, 27 OHM 1/4W 5% CARBON	3072700	1121
R0741	RESISTOR, 47 OHM 1/4W 5% CARBON	3074700	1121
R0745	RESISTOR, 27 OHM 1/4W 5% CARBON	3072700	1121
R0746	RESISTOR, 47 OHM 1/4W 5% CARBON	3074700	1121
R0750	RESISTOR, 10 OHM 1/4W 5% CARBON	3071000	1121
R0755	RESISTOR, 10 OHM 1/4W 5% CARBON	3071000	1121
R0757	RESISTOR, 301 OHM 1/4W 1% METAL FILM	3133010	7115
R0758	RESISTOR, 301 OHM 1/4W 1% METAL FILM	3133010	7115
R0759	RESISTOR, 4.7 OHM 1/4W 5% CARBON	3070047	1121
R0760	RESISTOR, 24900 OHM 1/4W 1% METAL FILM	3132492	7115
R0761	RESISTOR, 1000 OHM 1/4W 5% CARBON	3071102	1121
R0762	RESISTOR, 47 OHM 1/4W 5% CARBON	3074700	1121
R0763	RESISTOR, 40200 OHM 1/4W 1% METAL FILM	3134022	7115
R0764	RESISTOR, 40200 OHM 1/4W 1% METAL FILM	3134022	7115
R0765	RESISTOR, 1500 OHM 1/4W 1% METAL FILM	3131501	7115
R0766	RESISTOR, 200K OHM 1/4W 1% METAL FILM	3132003	7115
R0767	POTENTIOMETER, 10K OHM TRIM	3110150	71450
R0768	RESISTOR, 2700 OHM 1/4W 5% CARBON	3072702	1121

PART	DESCRIPTION	EXACT NO	MFG
R0770	RESISTOR, 3010 OHM 1/4W 1% METAL FILM	3133011	7115
R0775	RESISTOR, 1000 OHM 1/4W 5% CARBON	3071102	1121
R0780	RESISTOR, 51 OHM 1/4W 5% CARBON	3075510	1121
R0781	RESISTOR, 47 OHM 1/4W 5% CARBON	3074700	1121
R0782	RESISTOR, 499 OHM 1/4W 1% METAL FILM	3134990	7115
R0785	RESISTOR, 6190 OHM 1/4W 1% METAL FILM	3136191	7115
R0786	RESISTOR, 51 OHM 1/4W 5% CARBON	3075510	1121
R0787	RESISTOR, 68 OHM 1/4W 5% CARBON	3076800	1121
R0788	RESISTOR, 499 OHM 1/4W 1% METAL FILM	3134990	7115
R0790	RESISTOR, 806 OHM 1/4W 1% METAL FILM	3138060	7115
R0791	RESISTOR, 10 OHM 1/4W 5% CARBON	3071000	1121
R0795	RESISTOR, 7150 OHM 1/4W 1% METAL FILM	3137151	7115
R0796	RESISTOR, 806 OHM 1/4W 1% METAL FILM	3138060	7115
R0797	RESISTOR, 10 OHM 1/4W 5% CARBON	3071000	1121
R0798	RESISTOR, SELECTED VALUE		
R0800	RESISTOR, 27 OHM 1/4W 5% CARBON	3072700	1121
R0805	RESISTOR, 27 OHM 1/4W 5% CARBON	3072700	1121
R0810	RESISTOR, 10 OHM 1/4W 5% CARBON	3071000	1121
R0811	RESISTOR, 15 OHM 1/2W 5% CARBON	3011500	1121
R0812	RESISTOR, 10 OHM 1/4W 5% CARBON	3071000	1121
R0815	RESISTOR, 10 OHM 1/4W 5% CARBON	3071002	1121
R0816	RESISTOR, 15 OHM 1/2W 5% CARBON	3011500	1121
R0817	RESISTOR, 1500 OHM 1/4W 1% METAL FILM	3131501	7115
R0820	TO		
R0822	RESISTOR, 150 OHM 1/2W 1% METAL FILM	3101500	7115
R0823	RESISTOR, 26.1 OHM 1/4W 1% METAL FILM	3130261	7115
R0824	RESISTOR, 26.1 OHM 1/4W 1% METAL FILM	3130261	7115
R0825	RESISTOR, 34.8 OHM 1/4W 1% METAL FILM	3130348	7115
R0826	RESISTOR, 41.2 OHM 1/2W 1% METAL FILM	3100412	7115
R0827	RESISTOR, 41.2 OHM 1/2W 1% METAL FILM	3100412	7115
R0828	RESISTOR, 10.0 OHM 1/8W 1% METAL FILM	3100100	7115
R0829	RESISTOR, 46.4 OHM 1/2W 1% METAL FILM	3100464	7115
R0830	RESISTOR, 46.4 OHM 1/2W 1% METAL FILM	3100464	7115
R0831	RESISTOR, 3.16 OHM 1/8W 1% DEP. CARBON	3193160	7115
R0832	RESISTOR, 15 OHM 1/4W 5% CARBON	3071150	1121
R0833	RESISTOR, 1500 OHM 1/4W 5% CARBON	3071152	1121
R0834	RESISTOR, 576 OHM 1/4W 1% METAL FILM	3135760	7115
R0835	RESISTOR, 1500 OHM 1/4W 5% CARBON	3071152	1121
R0836	POTENTIOMETER, 5K OHM TRIM	3110149	71450
R0837	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R0838	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R0839	POTENTIOMETER, 10K OHM TRIM	3110150	71450
R0840	RESISTOR, 51 OHM 1/4W 5% CARBON	3075510	1121
R0841	RESISTOR, 10 OHM 1/4W 5% CARBON	3071000	1121
R0842	RESISTOR, 10 OHM 1/4W 5% CARBON	3071000	1121
R0843	RESISTOR, 1500 OHM 1/4W 5% CARBON	3071152	1121
R0844	RESISTOR, 15 OHM 1/4W 5% CARBON	3071150	1121
R0845	RESISTOR, 10 OHM 1/4W 5% CARBON	3071000	1121
R0846	RESISTOR, 301 OHM 1/4W 1% METAL FILM	3133010	7115
R0847	RESISTOR, 127 OHM 1/4W 1% METAL FILM	3131272	7115
R0848	RESISTOR, 750 OHM 1/4W 1% METAL FILM	3137500	7115
R0849	POTENTIOMETER, 100 OHM TRIM	3110141	71450
R0850	RESISTOR, 274 OHM 1/4W 1% METAL FILM	3132740	7115
R0851	RESISTOR, 2740 OHM 1/4W 1% METAL FILM	3132741	7115
R0852	RESISTOR, 866 OHM 1/4W 1% METAL FILM	3138660	7115
R0853	POTENTIOMETER, 10K OHM MIN	3110327	71450
R0854	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R0855	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R0856	RESISTOR, 1270 OHM 1/4W 1% METAL FILM	3131271	7115
R0857	RESISTOR, 680 OHM 1/2W 5% CARBON	3010681	1121
R0858	RESISTOR, 2370 OHM 1/2W 1% METAL FILM	3102371	7115
R0859	RESISTOR, 15 OHM 1/4W 5% CARBON	3071150	1121
R0860	RESISTOR, 475 OHM 1/2W 1% METAL FILM	3104750	7115
R0861	RESISTOR, 2490 OHM 1/4W 1% METAL FILM	3132491	7115
R0862	SWITCH, ROTARY	2600344	10597
R0863	RESISTOR, 100 OHM 1/4W 5% CARBON	3071101	1121
R0864	RESISTOR, 1470 OHM 1/4W 1% METAL FILM	3131471	7115
R0865	RESISTOR, 4700 OHM 1/4W 5% CARBON	3074472	1121
R0866	RESISTOR, 4700 OHM 1/4W 5% CARBON	3074472	1121
R0867	POTENTIOMETER, 100 OHM TRIM	3110141	71450
R0901	RESISTOR, 8250 OHM 1/4W 1% METAL FILM	3138251	7115
R0902	RESISTOR, 31600 OHM 1/4W 1% METAL FILM	3133162	7115
R0903	POTENTIOMETER, 2.5K OHM TRIM	3110148	71450
R0904	RESISTOR, 1000K OHM 1/4W 1% METAL FILM	3131004	7115
R0905	RESISTOR, 470 OHM 1/4W 5% CARBON	3074471	1121
R0910	RESISTOR, 15K OHM 1/4W 5% CARBON	3071153	1121
R0911	RESISTOR, 620 OHM 1/4W 5% CARBON	3076621	1121
R0930	POTENTIOMETER, 1K OHM	3110107	44655
R0931	POTENTIOMETER, 100 OHM TRIM	3110141	71450
R0932	RESISTOR, 82 OHM 1/4W 5% CARBON	3078200	1121
R0941	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R0942	RESISTOR, 499 OHM 1/4W 1% METAL FILM	3134990	7115
R0945	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R0950	RESISTOR, 1000 OHM 1/4W 5% CARBON	3071102	1121
R0952	RESISTOR, 274K OHM 1/4W 1% METAL FILM	3132743	7115
R0953	RESISTOR, 274K OHM 1/4W 1% METAL FILM	3132743	7115
R0954	POTENTIOMETER, 2K OHM PC TRIM	3110130	78488
R0955	RESISTOR, 10000K OHM 1/2W 1% DEP. CARBON	3091005	75042
R0956	RESISTOR, 1000K OHM 1/4W 1% METAL FILM	3131004	7115
R0957	RESISTOR, 100K OHM 1/4W 1% METAL FILM	3131003	7115
R0958	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R0959	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R0960	RESISTOR, 100 OHM 1/4W 5% CARBON	3071101	1121
R0961	RESISTOR, 560 OHM 1/4W 5% CARBON	3075610	1121
R0962	RESISTOR, 3320 OHM 1/4W 1% METAL FILM	3133321	7115
R0963	RESISTOR, 1820 OHM 1/4W 1% METAL FILM	3131821	7115
R0964	RESISTOR, 1000 OHM 1/4W 5% CARBON	3071102	1121
R0965	RESISTOR, 3000 OHM 1/4W 5% CARBON	3073002	1121
R0966	RESISTOR, 390 OHM 1/4W 5% CARBON	3073901	1121
R0967	RESISTOR, 3320 OHM 1/4W 1% METAL FILM	3133321	7115
R0971	RESISTOR, 750 OHM 1/4W 5% CARBON	3077501	1121
R0975	RESISTOR, 100 OHM 1W 10% CARBON	3041101	1121
R0980	RESISTOR, 750 OHM 1/4W 5% CARBON	3077501	1121
R0985	RESISTOR, 383 OHM 1/2W 1% METAL FILM	3103830	7115
R1001	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R1005	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R1010	RESISTOR, 1000 OHM 1/4W 5% CARBON	3071102	1121
R1012	RESISTOR, 274K OHM 1/4W 1% METAL FILM	3132743	7115
R1013	RESISTOR, 274K OHM 1/4W 1% METAL FILM	3132743	7115
R1014	POTENTIOMETER, 2K OHM PC TRIM	3110130	78488
R1015	RESISTOR, 10000K OHM 1/2W 1% DEP. CARBON	3091005	75042
R1016	RESISTOR, 1000K OHM 1/4W 1% METAL FILM	3131004	7115

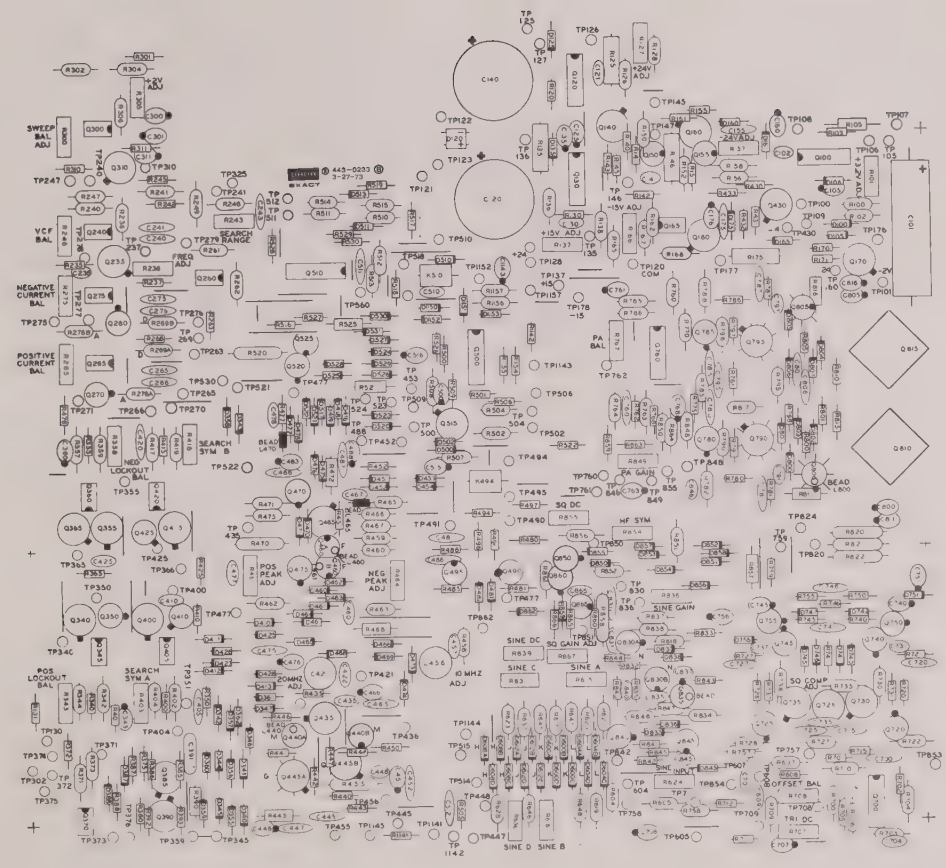
PART	DESCRIPTION	EXACT NO	MFG
R1017	RESISTOR, 100K OHM 1/4W 1% METAL FILM	3131003	7115
R1018	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R1019	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R1020	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R1021	POTENTIOMETER, 10K OHM TRIM	3110150	71450
R1022	RESISTOR, 100K OHM 1/4W 1% METAL FILM	3131003	7115
R1023	RESISTOR, 470 OHM 1/4W 5% CARBON	3070471	1121
R1024	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R1025	RESISTOR, 3600 OHM 1/4W 5% CARBON	3070362	1121
R1026	RESISTOR, 2000 OHM 1/4W 5% CARBON	3070202	1121
R1027	RESISTOR, 2.0 OHM 1/2W 5% CARBON	3010020	1121
R1030	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R1032	RESISTOR, 274K OHM 1/4W 1% METAL FILM	3132743	7115
R1033	RESISTOR, 274K OHM 1/4W 1% METAL FILM	3132743	7115
R1034	POTENTIOMETER, 2K OHM PC TRIM	3110130	78488
R1035	RESISTOR, 10000K OHM 1/2W 1% DEP, CARBON	3091005	75042
R1036	RESISTOR, 1000K OHM 1/4W 1% METAL FILM	3131004	7115
R1037	RESISTOR, 100K OHM 1/4W 1% METAL FILM	3131003	7115
R1038	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R1039	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R1040	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R1051	RESISTOR, 47 OHM 1/4W 5% CARBON	3070470	1121
R1052	RESISTOR, 620 OHM 1/4W 5% CARBON	3070621	1121
R1053	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R1061	RESISTOR, 15K OHM 1/4W 5% CARBON	3070153	1121
R1070	RESISTOR, 8200 OHM 1/4W 5% CARBON	3070822	1121
R1071	RESISTOR, 68100 OHM 1/4W 1% METAL FILM	3136812	7115
R1072	POTENTIOMETER, 2K OHM PC TRIM	3110130	78488
R1073	RESISTOR, 13000 OHM 1/4W 1% METAL FILM	3131302	7115
R1074	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R1100	RESISTOR, 665 OHM 1/4W 1% METAL FILM	3136650	7115
R1101	RESISTOR, 665 OHM 1/4W 1% METAL FILM	3136650	7115
R1103	RESISTOR, 2320 OHM 1/4W 1% METAL FILM	3132321	7115
R1110	RESISTOR, 221 OHM 1/2W 1% METAL FILM	3102210	7115
R1111	RESISTOR, 1600 OHM 1/4W 5% CARBON	3070162	1121
R1112	RESISTOR, 330 OHM 1/4W 5% CARBON	3070331	1121
R1120	RESISTOR, 2320 OHM 1/4W 1% METAL FILM	3132321	7115
R1121	RESISTOR, 4220 OHM 1/4W 1% METAL FILM	3134221	7115
R1122	RESISTOR, 332 OHM 1/4W 1% METAL FILM	3133320	7115
R1123	RESISTOR, 42200 OHM 1/4W 1% METAL FILM	3134222	7115
R1124	POTENTIOMETER, 20K OHM PC TRIM	3110131	78488
R1125	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R1126	RESISTOR, 150K OHM 1/4W 5% CARBON	3070154	1121
R1127	RESISTOR, 1500K OHM 1/4W 5% CARBON	3070155	1121
R1128	RESISTOR, 680 OHM 1/4W 5% CARBON	3070681	1121
R1130	RESISTOR, 887 OHM 1/4W 1% METAL FILM	3138870	7115
R1131	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R1132	RESISTOR, 4320 OHM 1/4W 1% METAL FILM	3134321	7115
R1135	RESISTOR, 560 OHM 1/2W 5% CARBON	3010561	1121
R1136	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R1140	RESISTOR, 1600 OHM 1/4W 5% CARBON	3070162	1121
R1141	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472	1121
R1142	RESISTOR, 10K OHM 1/4W 5% CARBON	3070103	1121
R1143	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R1150	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472	1121
R1151	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R1152	RESISTOR, 365 OHM 1/4W 1% METAL FILM	3133650	7115
R1153	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R1154	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R1155	RESISTOR, 33 OHM 1/4W 5% CARBON	3070330	1121
R1156	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R1157	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R1158	RESISTOR, 33K OHM 1/4W 5% CARBON	3070333	1121
R1159	RESISTOR, 365 OHM 1/4W 1% METAL FILM	3133650	7115
R1160	RESISTOR, 680 OHM 1/2W 5% CARBON	3010681	1121
R1161	RESISTOR, 221 OHM 1/2W 1% METAL FILM	3102210	7115
R1162	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R1163	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102	1121
R1170	RESISTOR, 820 OHM 1/2W 5% CARBON	3010821	1121
R1171	POTENTIOMETER, 250 OHM	3110145	71450
R1172	RESISTOR, 1210 OHM 1/4W 1% METAL FILM	3131211	7115
R1173	RESISTOR, 1210 OHM 1/4W 1% METAL FILM	3131211	7115
R1174	POTENTIOMETER, 250 OHM	3110145	71450
R1200	RESISTOR, 33 OHM 1/4W 5% CARBON	3070330	1121
R1201	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472	1121
R1202	RESISTOR, 270 OHM 1/2W 5% CARBON	3010271	1121
R1203	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100	1121
R1210	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472	1121
R1211	RESISTOR, 270 OHM 1/2W 5% CARBON	3010271	1121
R1212	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100	1121
R1213	RESISTOR, 47 OHM 1/4W 5% CARBON	3070470	1121
S0100	SWITCH, TOGGLE SPDT	2600103	100005
S0101	SWITCH, SLIDE	2600319	10597
S0205	SWITCH, PUSH BUTTON	2600359	10597
S0310	CONCENTRIC SWITCH & POTENTIOMETER	2600313	71450
S0320	CONCENTRIC SWITCH & POTENTIOMETER	2600313	71450
S0400	SWITCH, ROTARY	2600345	10597
S0500	SWITCH, PUSH BUTTON	2600359	10597
S0505	SWITCH, PUSH BUTTON	2600359	10597
S0510	SWITCH, PUSH BUTTON	2600359	10597
S0513	SWITCH, PUSH BUTTON	2600359	10597
S0514	SWITCH, PUSH BUTTON	2600359	10597
S0515	SWITCH, PUSH BUTTON	2600359	10597
S0700	SWITCH, ROTARY	2600344	10597
S0705	SWITCH, PUSH BUTTON	2600360	10597
S0710	SWITCH, PUSH BUTTON	2600360	10597
S0800	SWITCH, PUSH BUTTON	2600360	10597
S0810	SWITCH, PUSH BUTTON	2600360	10597
S0820	SWITCH, PUSH BUTTON	2600360	10597
S0837	SWITCH, PUSH BUTTON	2600360	10597
S0950	SWITCH, ROTARY	2600345	10597
S0972	SWITCH, PUSH BUTTON	2600358	10597
S1014	SWITCH, PUSH BUTTON	2600360	10597
S1150	SWITCH, PUSH BUTTON	2600360	10597
T0100	TRANSFORMER, POWER	1200042	10597

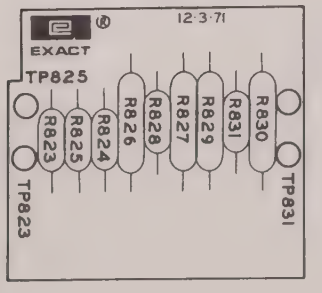
SECTION 6

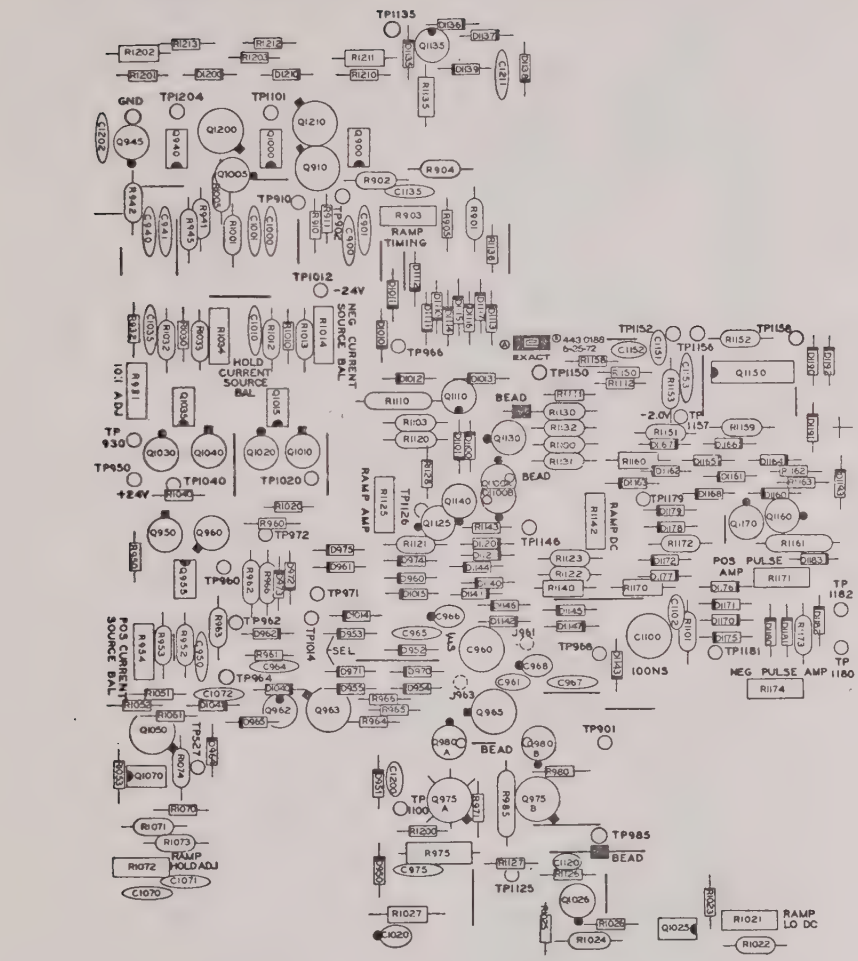
PARTS OVERLAY AND SCHEMATICS

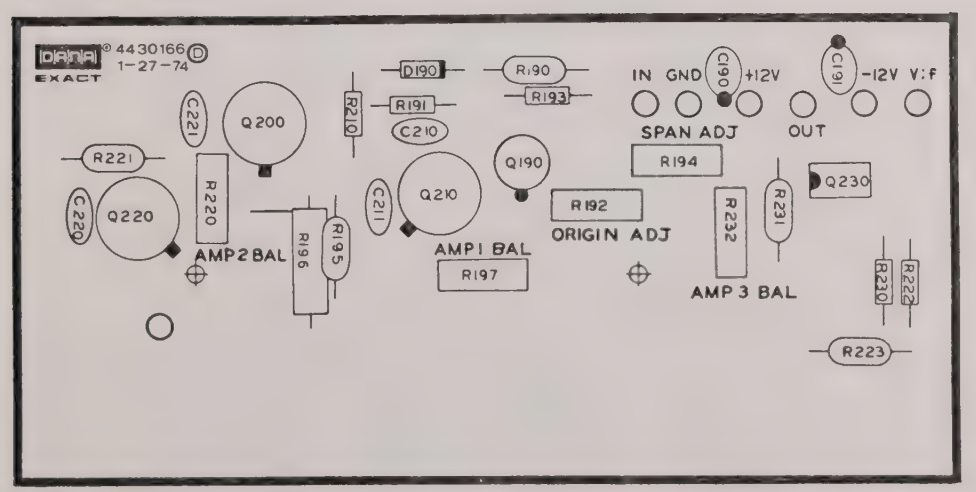
FOREWORD TO SCHEMATICS

To facilitate quick reference to inter-connections from one schematic to another, a system of numbers has been utilized. Each schematic carries its own identifying number located in a large hexagonal shape near the title. When a connection is referred to, a small hex encompasses the number of the schematic that contains the connection. Use the Connection Reference Chart to locate where reference numbers are shown, but no actual schematic exists for that particular model.


SWEEP BAL ADJ
VCF BAL
NEGATIVE CURRENT BAL
POSITIVE CURRENT BAL
SEARCH RANGE
FREQ ADJ
SEARCH SYM B
NEG LOCKOUT BAL
POS PEAK ADJ
NEG PEAK ADJ
SEARCH SYM A
POS LOCKOUT BAL
10 MHZ ADJ
SINE DC
SINE C
SINE A
SINE D
SINE B
SQ GAIN ADJ
SINE GAIN
SQ COMP ADJ
SQ DC
HF SYM
PA BAL
PA GAIN
+15V ADJ
-15V ADJ
+24V ADJ
-24V ADJ
+2V ADJ
-2V ADJ
OFFSET BAL
TRI DC
VCF
EXACT
443-0233 B
3-27-73


12-3-71
EXACT
TP825
R823
R825
R824
R826
R828
R827
R829
R831
R830
TP823
TP831


TP1135
GND
TP1204
TP1101
TP910
RAMP TIMING
TP1012
-24V
NEG CURRENT SOURCE BAL
HOLD CURRENT SOURCE BAL
10:1 ADJ
TP 930
TP950
+24V
TP1040
TP1020
TP966
EXACT
TP1150
TP1152
TP1156
TP1158
-2.0V
TP 1157
BEAD
RAMP AMP
TP1125
TP1146
RAMP DC
POS PULSE AMP
NEG PULSE AMP
TP 1182
TP 1180
TP960
TP971
TP962
TP964
TP1014
SEL
POS CURRENT SOURCE BAL
100NS
TP901
TP1100
TP985
TP1125
RAMP HOLD ADJ
RAMP LO DC


DANA
4430166
1-27-74
EXACT
IN GND
+12V
-12V
V:F
SPAN ADJ
OUT
AMP2 BAL
AMP1 BAL
ORIGIN ADJ
AMP 3 BAL

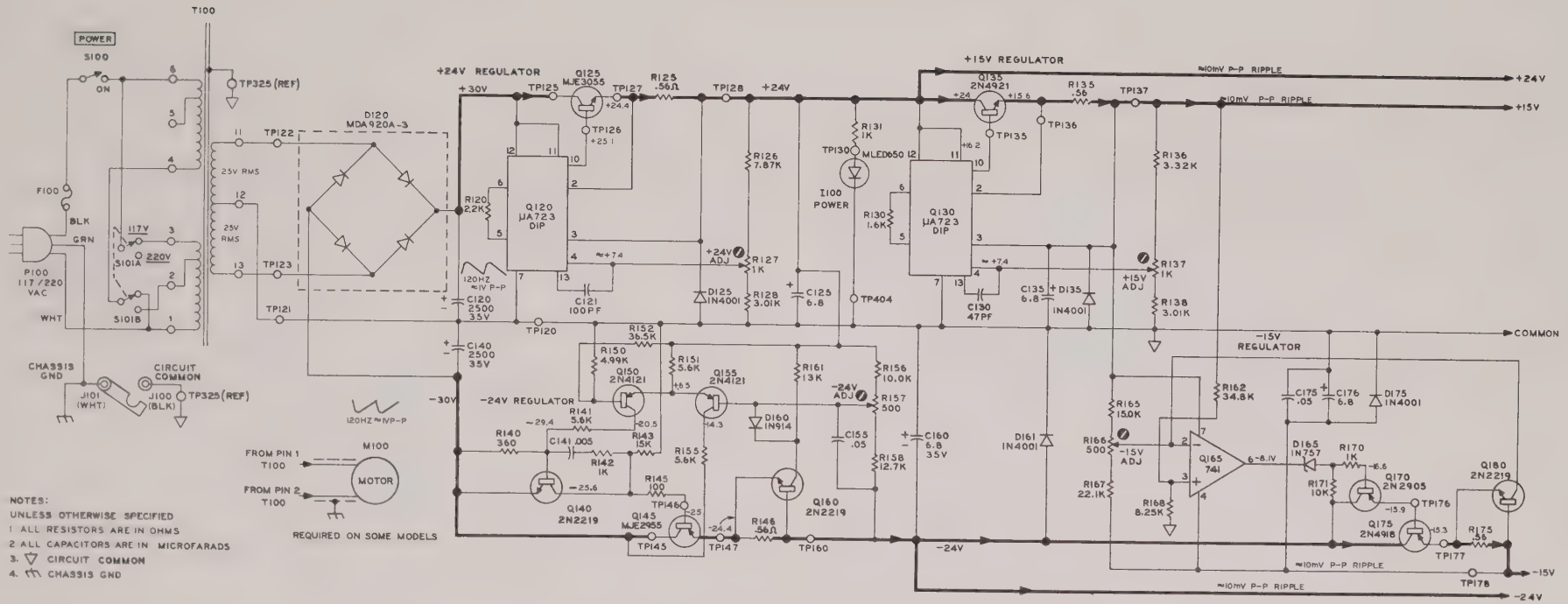
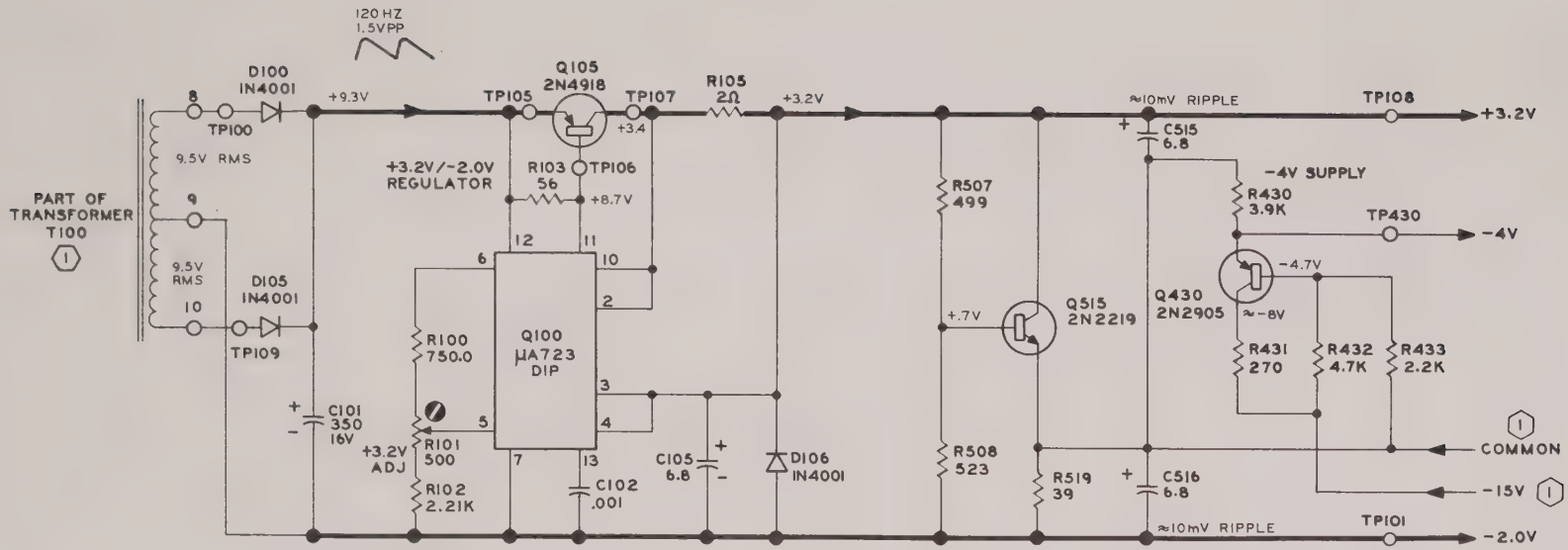
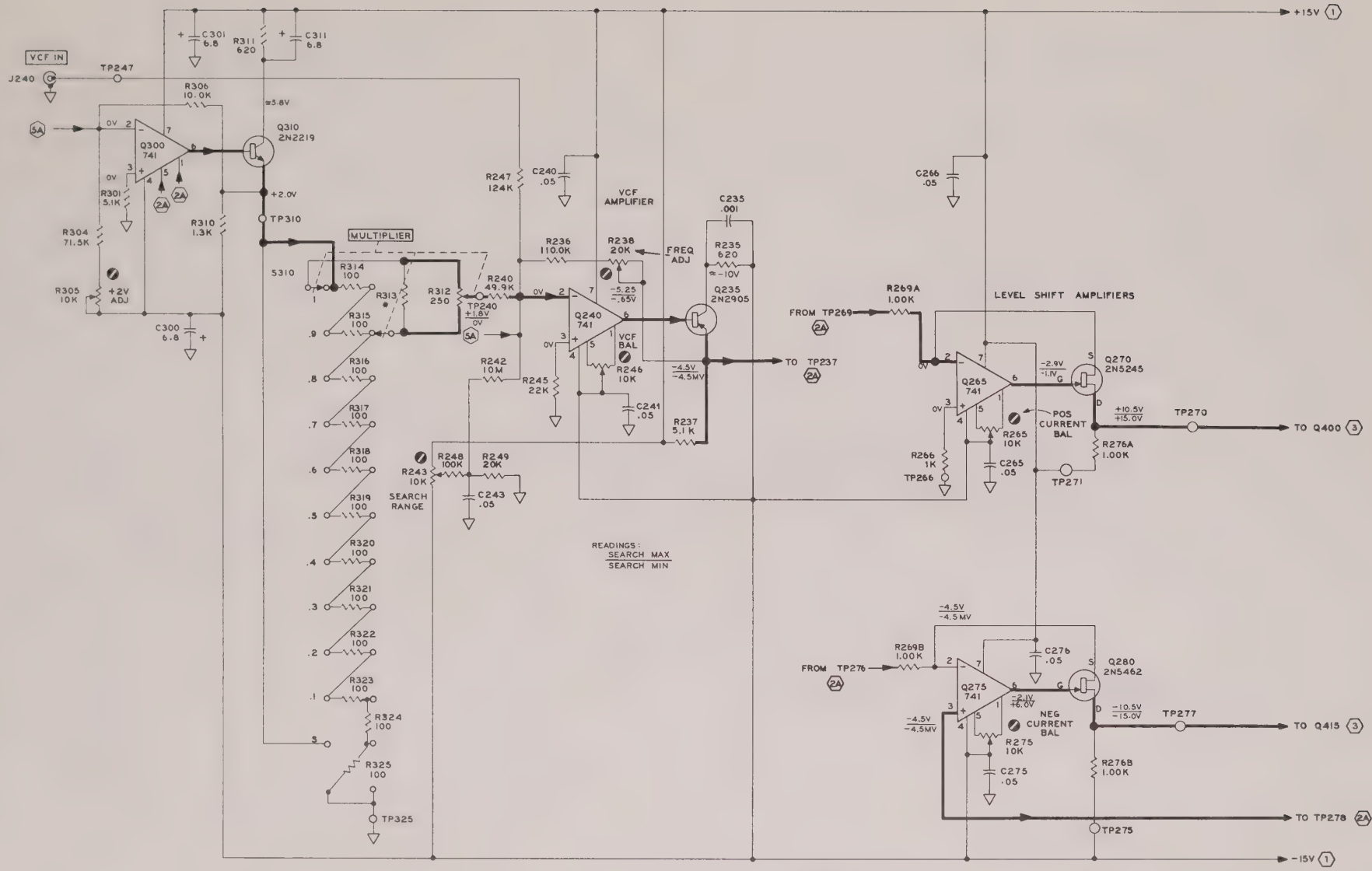


FIGURE 6.2.1
(1) SCHEMATIC DIAGRAM
POWER SUPPLY CIRCUIT
REV (A) (B)



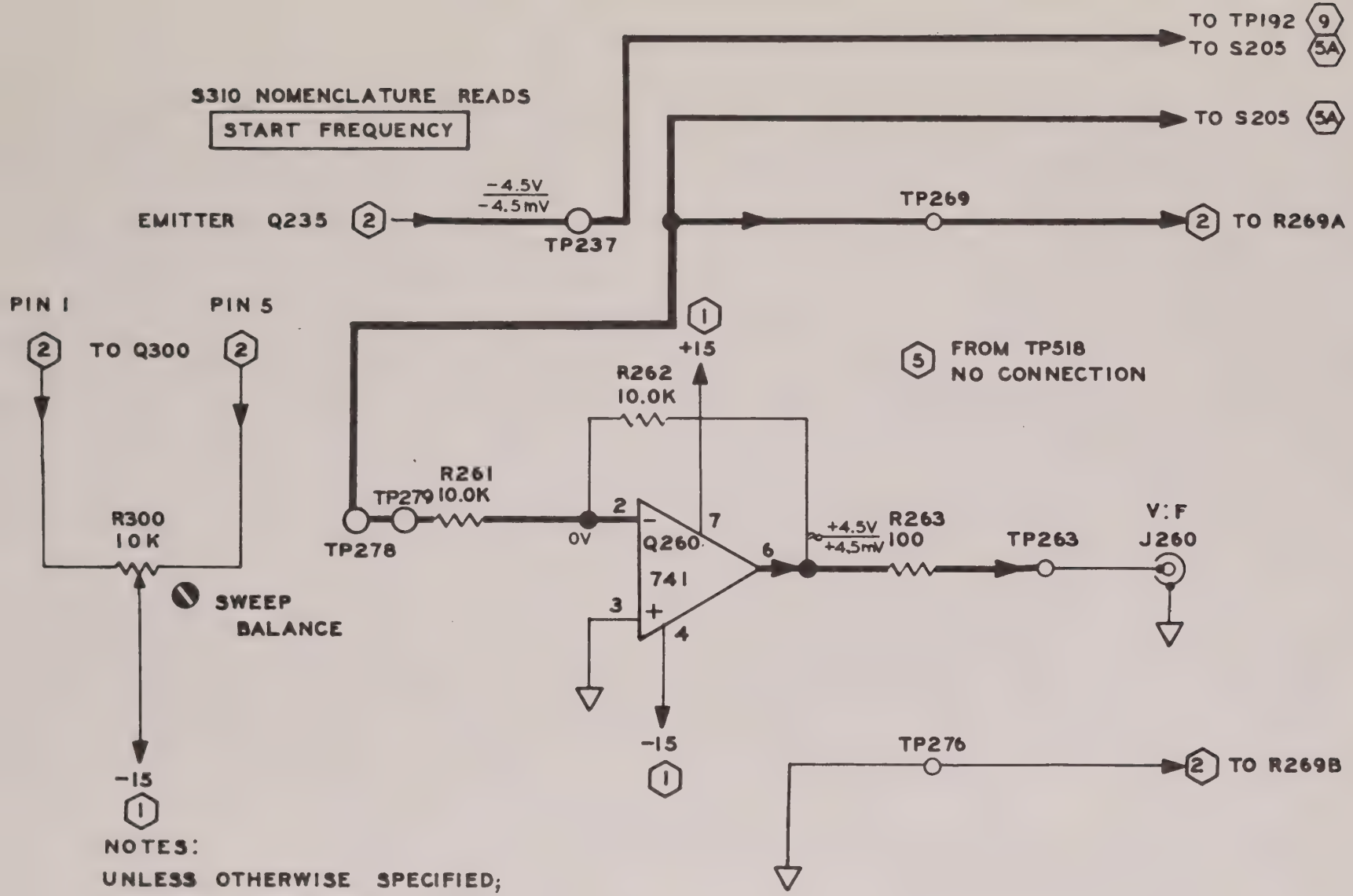
NOTES:
UNLESS OTHERWISE SPECIFIED;
1. ALL RESISTORS ARE IN OHMS
2. ALL CAPACITORS ARE IN MICROFARADS

1A FIGURE 6.2.2
SCHEMATIC-LOGIC POWER SUPPLY Ⓑ Ⓒ Ⓔ Ⓕ



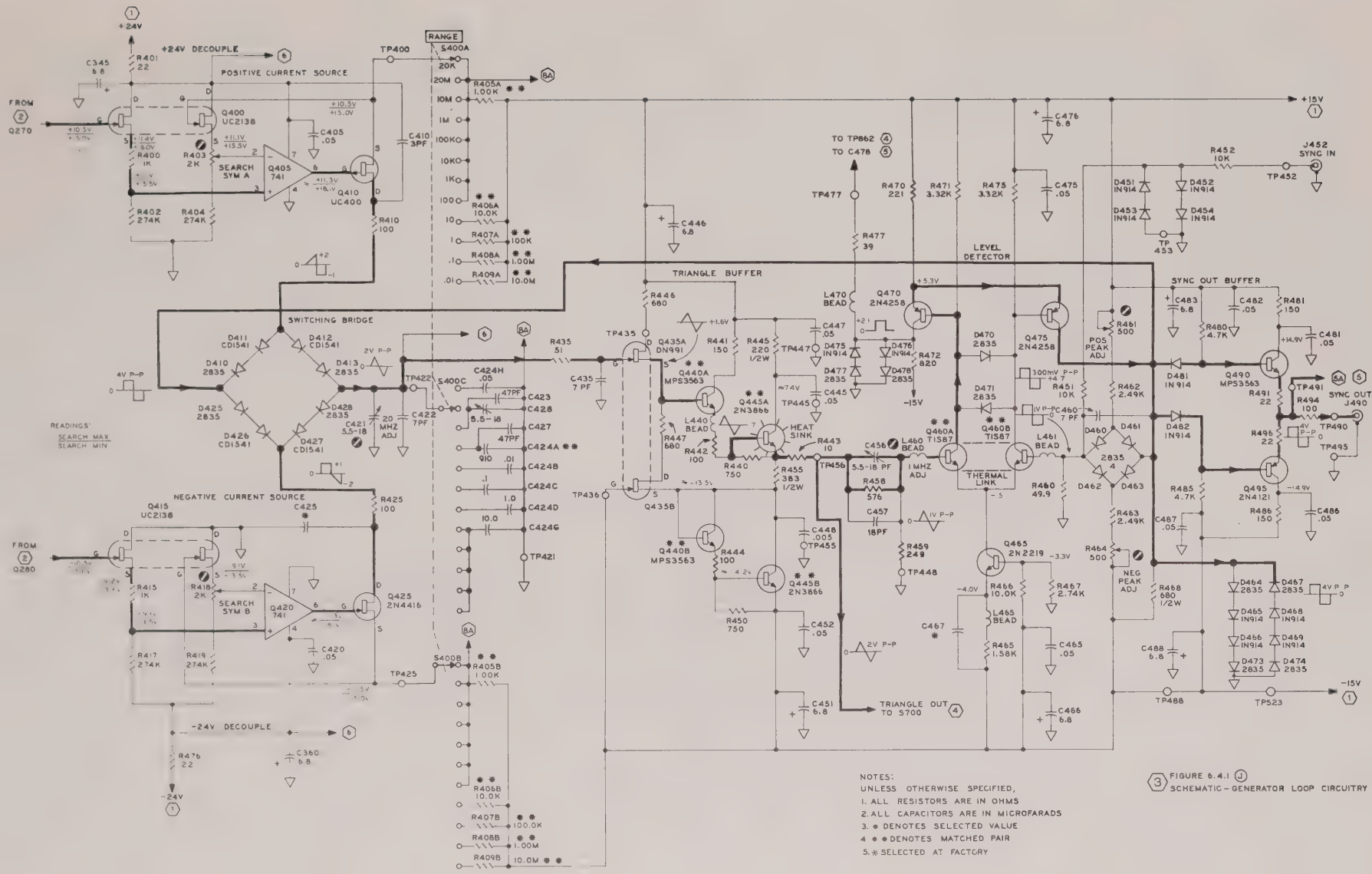
NOTES:
UNLESS OTHERWISE SPECIFIED;
1. ALL RESISTORS ARE IN OHMS
2. ALL CAPACITORS ARE IN MICROFARADS
3. * DENOTES SELECTED VALUE

(2) FIGURE 6.3.1
SCHEMATIC-FREQUENCY CONTROL CIRCUIT (E)
REV (A) (B)



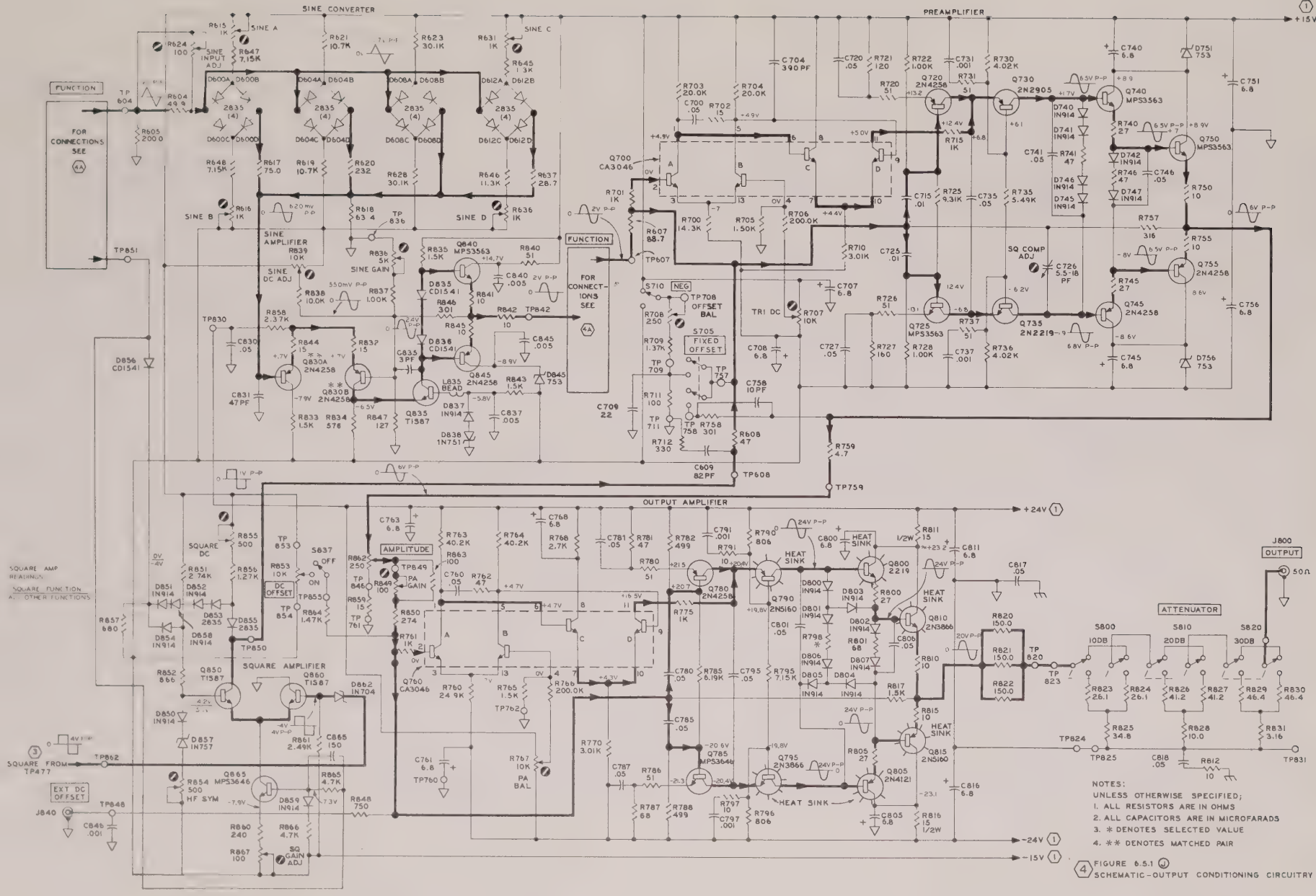
2A FIGURE 6.3.2
SCHEMATIC – FREQUENCY CONTROL CONNECTION
REV (A)

(E)

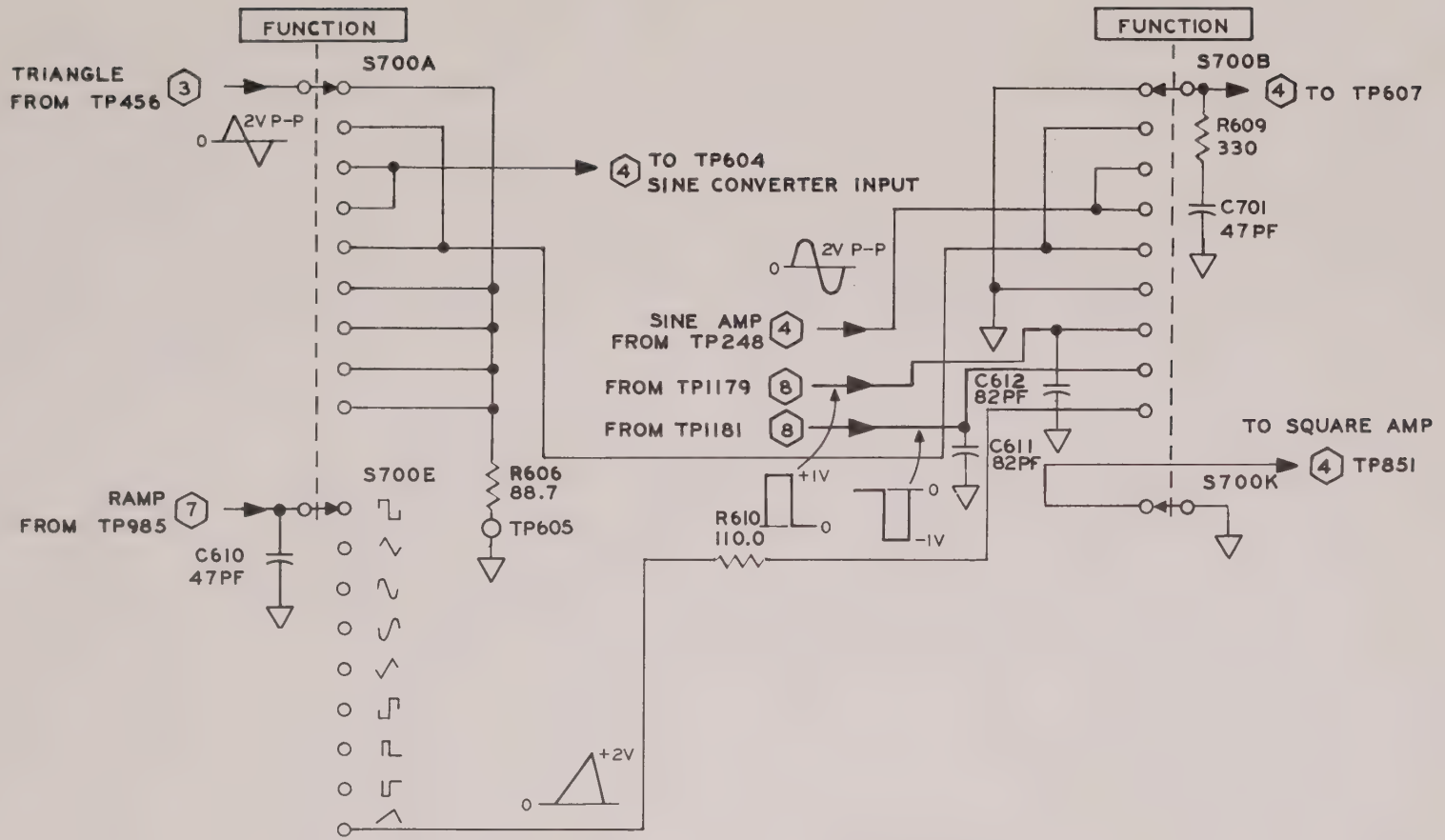


NOTES:
UNLESS OTHERWISE SPECIFIED,
1. ALL RESISTORS ARE IN OHMS
2. ALL CAPACITORS ARE IN MICROFARADS
3. ● DENOTES SELECTED VALUE
4. ● ● DENOTES MATCHED PAIR
5. ✱ SELECTED AT FACTORY

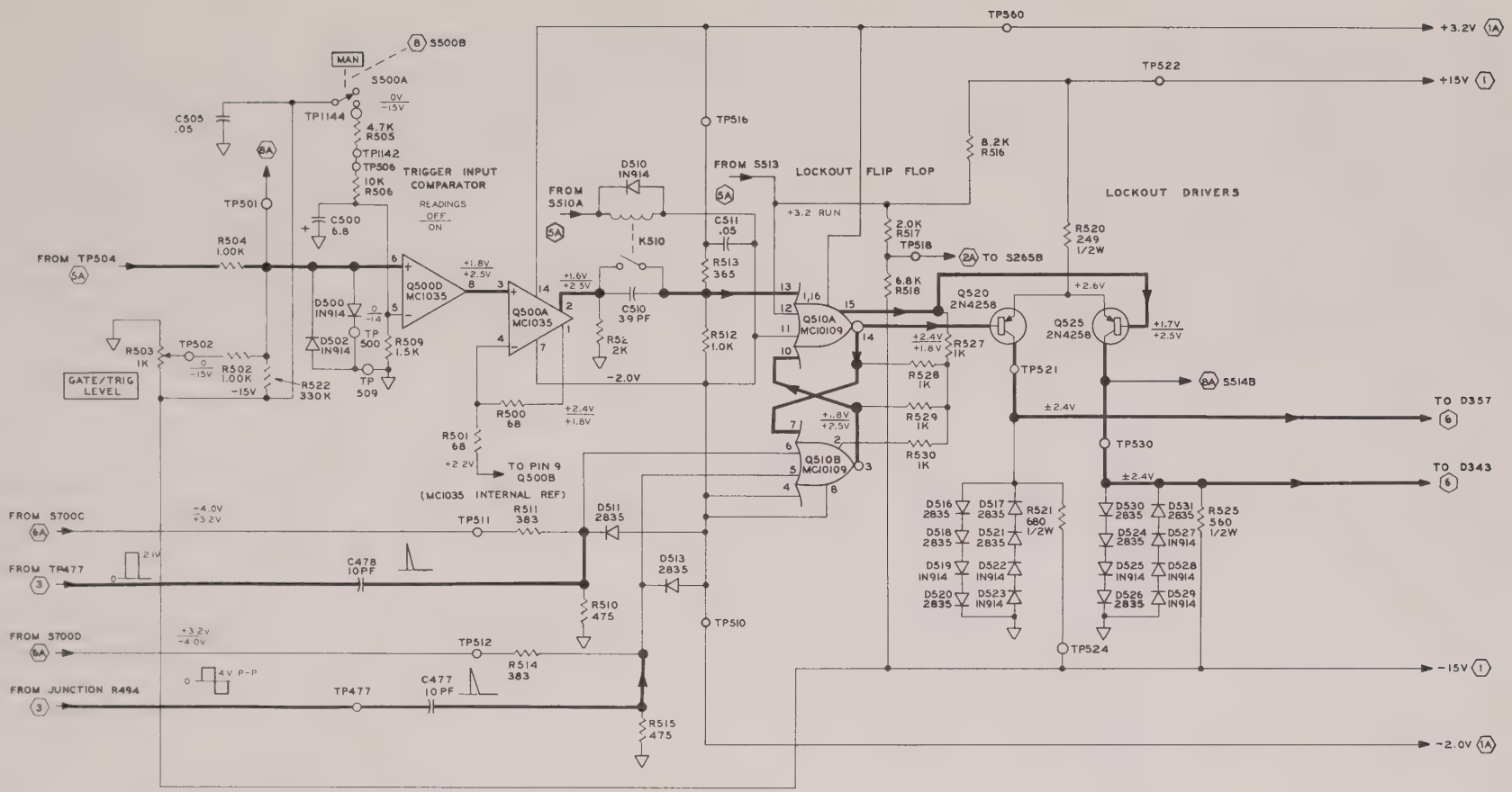
3 FIGURE 6.4.1 (J)
SCHEMATIC – GENERATOR LOOP CIRCUITRY



4 FIGURE 6.5.1 (J)
SCHEMATIC - OUTPUT CONDITIONING CIRCUITRY

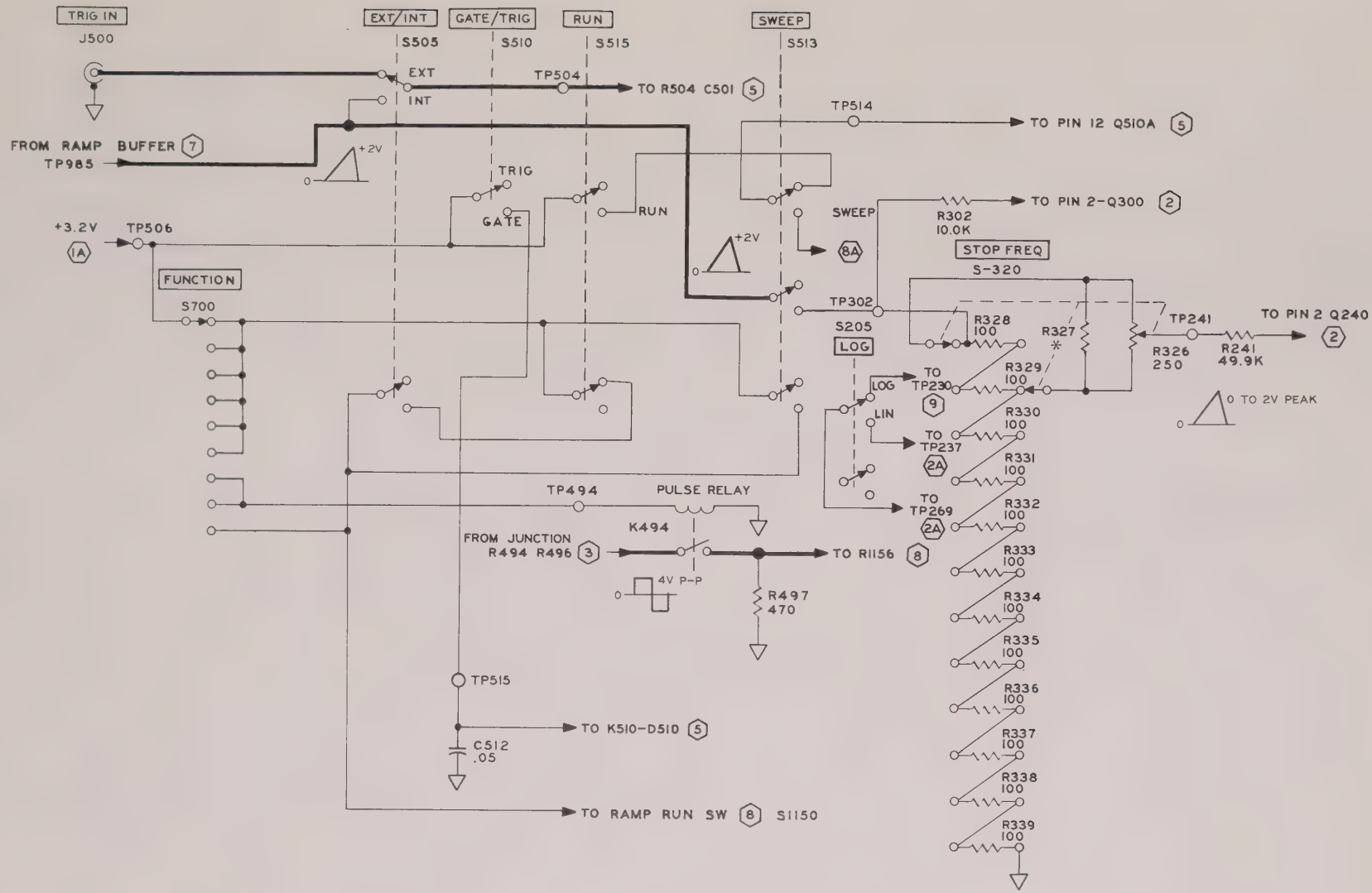


4A FIGURE 6.5.2
SCHEMATIC - FUNCTION SWITCHING (J)
(A)



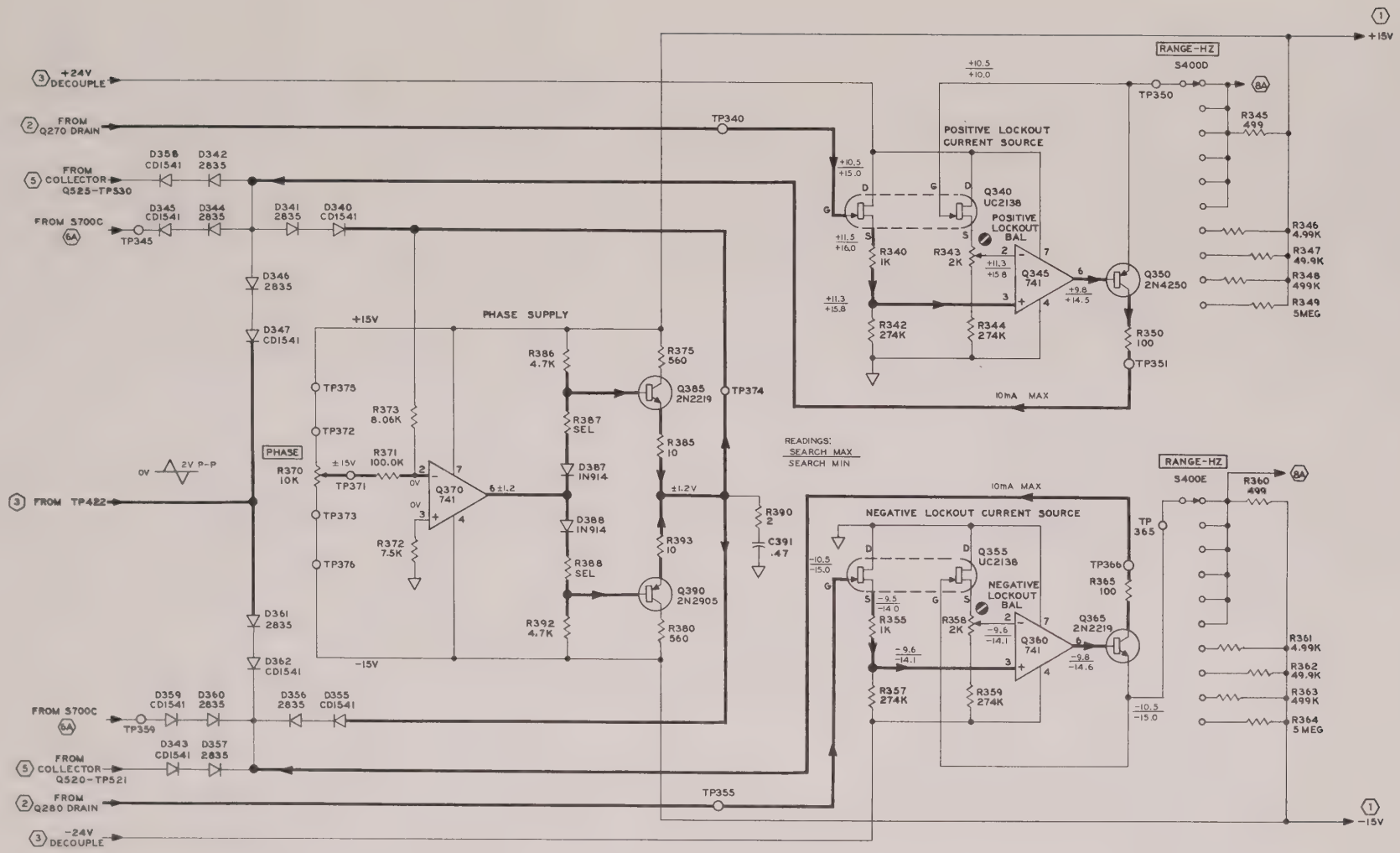
NOTES:
UNLESS OTHERWISE SPECIFIED;
1. ALL RESISTORS ARE IN OHMS
2. ALL CAPACITORS ARE IN MICROFARADS

5 FIGURE 6.6.1
SCHEMATIC-LOCKOUT LOGIC G
A



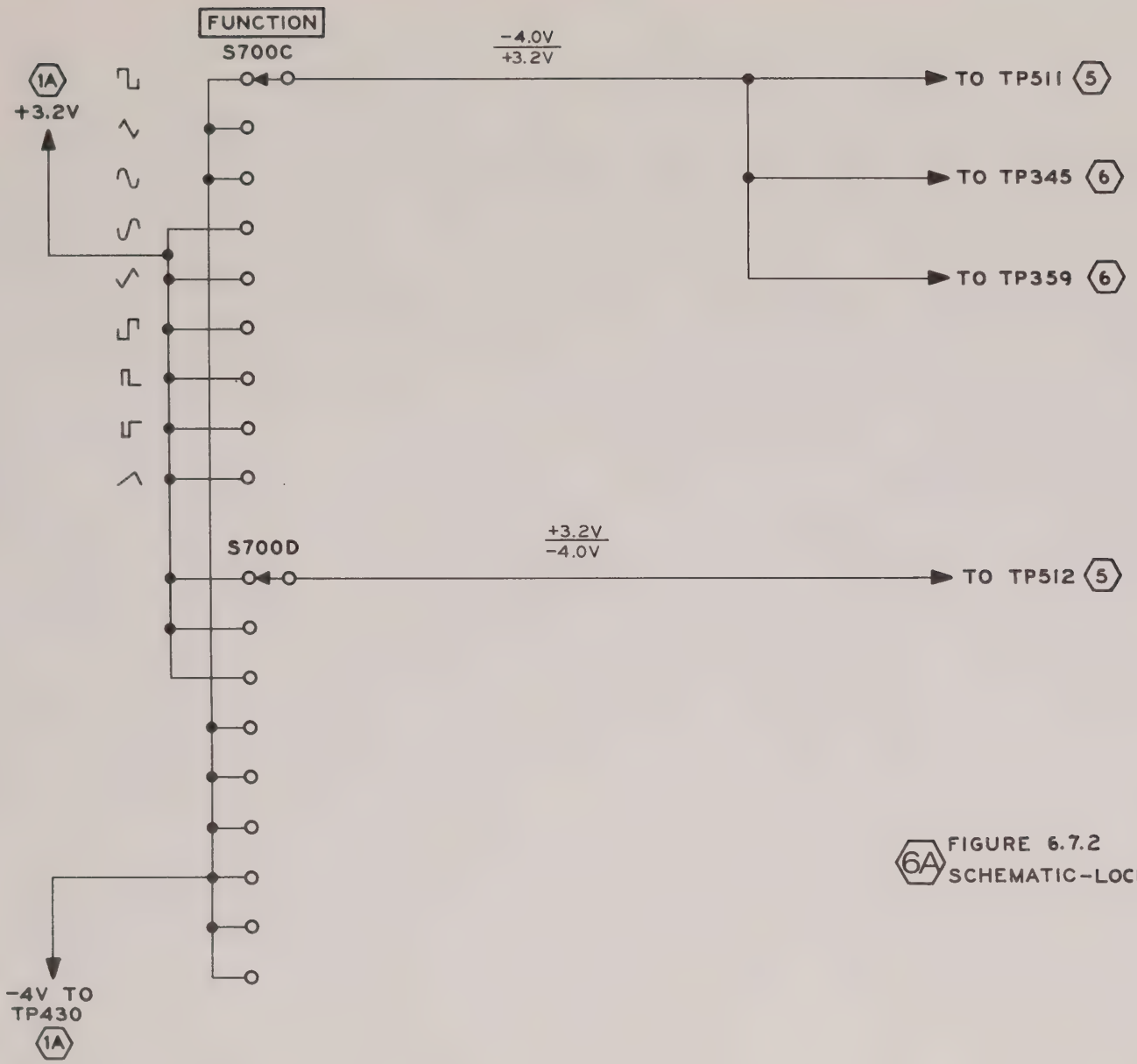
NOTES:
UNLESS OTHERWISE SPECIFIED;
1. ALL RESISTORS ARE IN OHMS
2.* DENOTES SELECTED VALUE

5A FIGURE 6.6.2
SCHEMATIC - MODE SWITCHING (E)
REV (A)

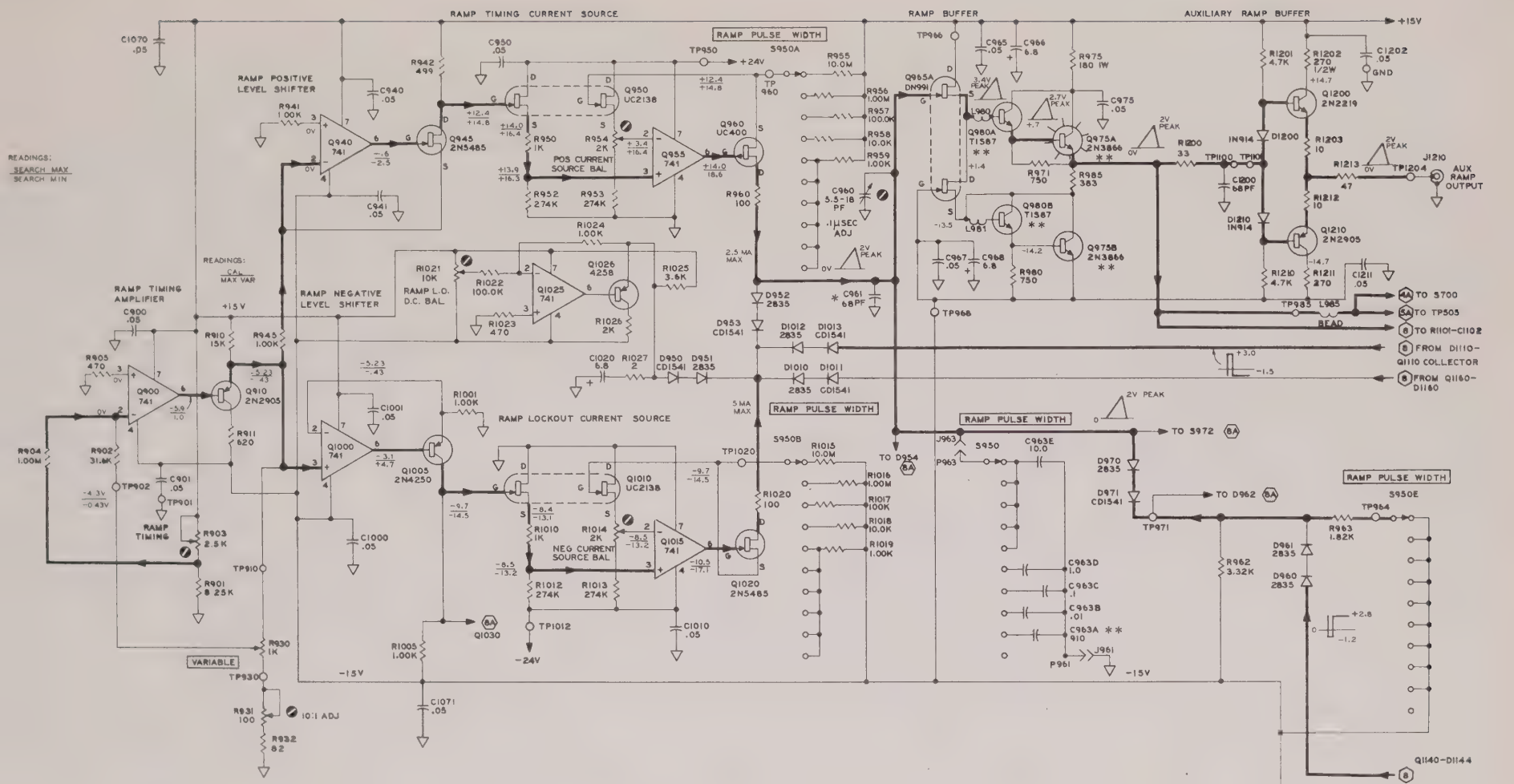


NOTES:
UNLESS OTHERWISE SPECIFIED;
1. ALL RESISTORS ARE IN OHMS
2. ALL CAPACITORS ARE IN MICROFARADS

6 FIGURE 6.7.1
SCHEMATIC-LOCKOUT AMPLIFIER (B)(C)(E)(G)
REV (A)(B)



6A FIGURE 6.7.2
SCHEMATIC-LOCKOUT SELECTOR © (E)



NOTES:
UNLESS OTHERWISE SPECIFIED;
1. ALL RESISTORS ARE IN OHMS
2. ALL CAPACITORS ARE IN MICROFARADS
3. * * DENOTES MATCHED PAIR
4. * VALUE MAY VARY IN SOME MODELS

7 FIGURE 6.8.1
SCHEMATIC-RAMP LOCKOUT AND FREQUENCY CONTROL © (E)
REV (A)

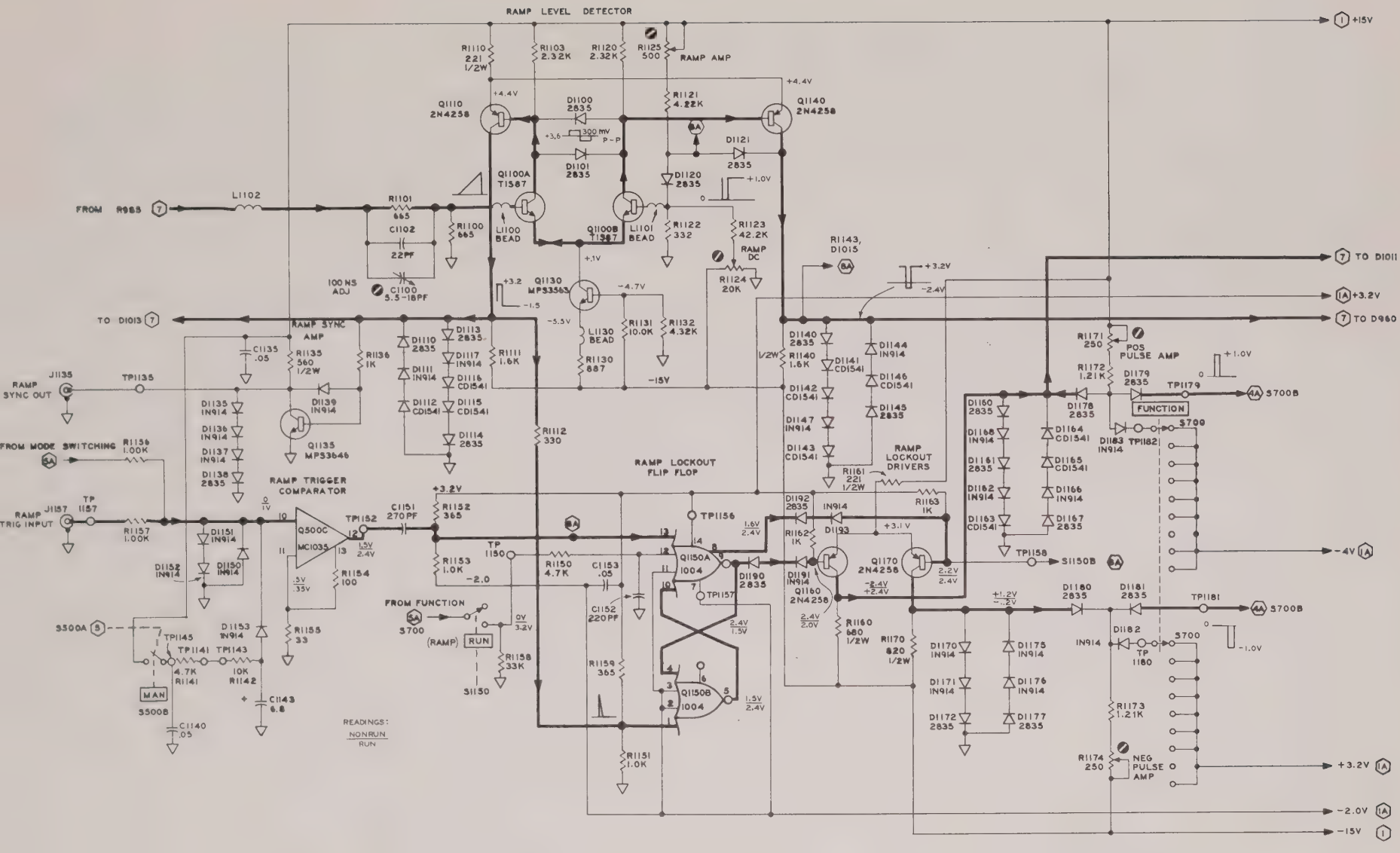
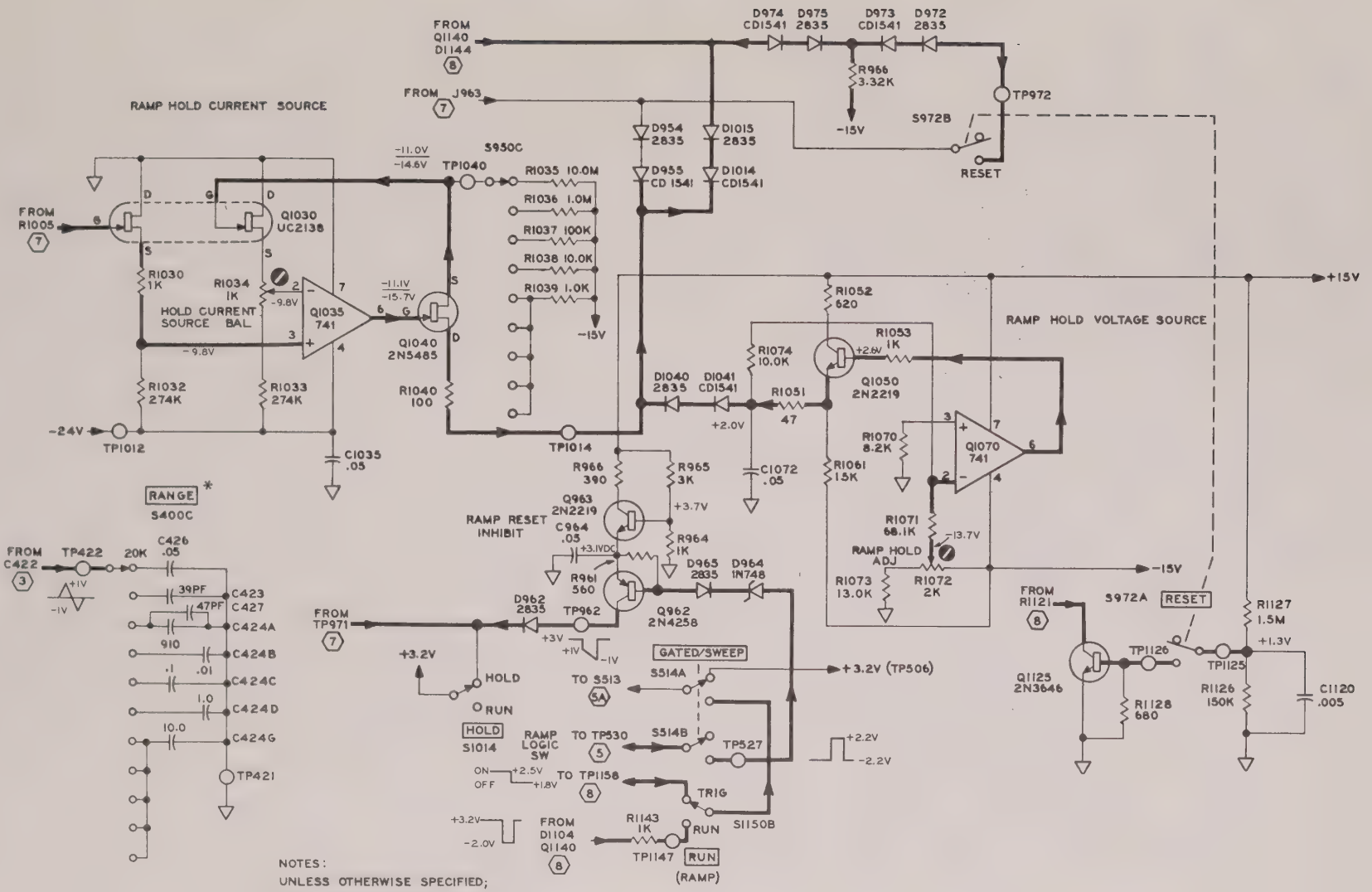
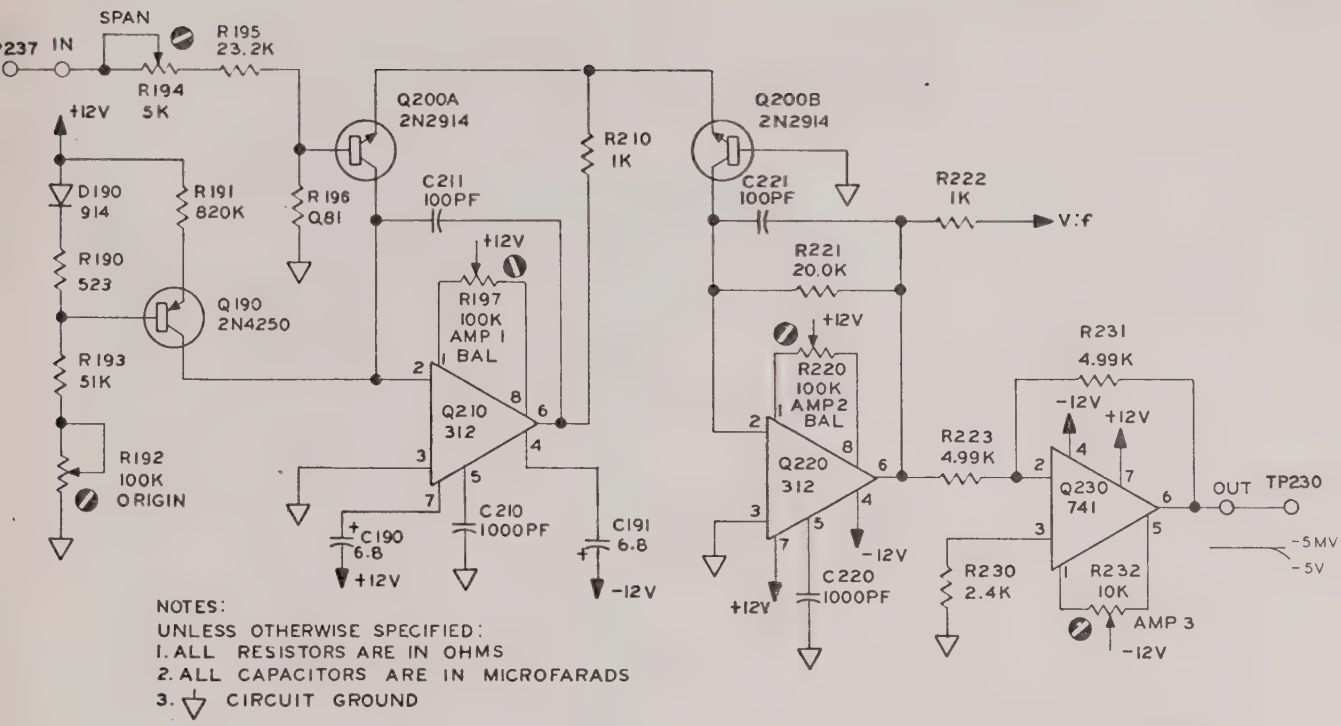


FIGURE 6.8.2
SCHEMATIC-RAMP LEVEL DETECTOR © (E) AND LOCKOUT CIRCUITS
REV (B)



NOTES:
UNLESS OTHERWISE SPECIFIED;
1. ALL RESISTORS ARE IN OHMS
2. ALL CAPACITORS ARE IN MICROFARADS
3. * SHOWN WITH EXTRA RANGE

8A FIGURE 6.8.3
SCHEMATIC – GATED SWEEP & HOLD CIRCUITS
REV B



NOTES:
UNLESS OTHERWISE SPECIFIED:
1. ALL RESISTORS ARE IN OHMS
2. ALL CAPACITORS ARE IN MICROFARADS
3. ⏚ CIRCUIT GROUND

SCHEMATIC DIAGRAM
LOG AMP MODEL 7071
1-17-75 REV

CONNECTION REFERENCE CHART

ON SCHEMATIC	SCHEMATIC REFERRED TO	CONDITION
(5) Tp501	(8A)	No other connections necessary
(7) From R1005	(8A)	No connections necessary
(7) From tp963	(8A)	No connections this model
(7) From tp971	(8A)	No connections this model
(7) From D970	(8A)	No connections this model
(8) From pin 13 Q1150A	(8A)	No connections this model
(8) Junction D1120 and D1121	(8A)	No connections this model
(8) Junction D1140 and R1140	(8A)	No connections this model
(5) From tp530	(8A)	No other connection this model
(3) S400	(8A)	No other connections this model
(3) S400	(8A)	No other connections this model

SECTION 7

ADDENDA

At EXACT we continually strive to incorporate latest electronic developments by adding circuit and component improvements to our instrument line as they are developed and tested.

At times, due to printing and shipping requirements, change information is not entered in the main body of the manual. It therefore may contain new change information in the following pages of this section. If change pages do not appear in this section, your manual is correct as printed.

ADDENDA
Model 7271

On both the manual page labeled "Figure 4.1.0 Adjustment Location Detail," and the manual "Parts Overlay" page, the component that is actually C726 is incorrectly drawn and labeled as Q726.

On Schematic 4A, change C610 from 47pf to 150pf.
On Schematic 6, D358 and D343 should be reversed. D343 should be where D358 is, and D358 should be where D343 is.

DANA EXACT ELECTRONICS, INC.
2-5-75

ADDENDA

Models 7060, 7071, 7260, 7271

1. Change R1172 and R1173 from 1.21K 1/4W 1% to 1.27K 1/4W 1% Resistors.

2. Change R610 from 110Ω 1/4W 1% to 121 Ω 1/4W 1% Resistor on Function Switch.

3. Add C1136, 39pf Capacitor from the base of Q1135 to Ground.

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4-10-75

3. Using DVM (with tp325 as Common)

   A. Probe tp302 and adjust Sweep Bal Adjust for 0.000V ± .1mv.
   B. Probe tp247 and adjust VCF Bal Adjust for 0.000V ± .1mv.
   B2. Connect DVM from gnd (tp325) to tp310. Adjust +2V Adjust to obtain 2.000V ± 0mv -3mv.
   C. Set Start Dial to .10 and measure the voltage at tp237.
   D. Connect DVM across R-276B at tp277 and tp275 (refer to Adjustment Location Detail Figure 4.1.0) and adjust Negative Current Bal Adjust for a reading of the same absolute value of the same reading obtained in "C" above ± .5mv.
   E. Connect DVM across R-276A at tp270 and tp271 (refer to Adjustment Location Detail Figure 4.1.0) and adjust the Positive Current Bal Adjust for an absolute value of the same reading obtained in "C" above ± .5mv.
   F. Set Multiplier to S-0. Adjust the Search Range Adjust for a voltage between -4 and -5 millivolts at tp237.

4. Set Function to Triangle, Range to 100K, Multiplier to S-X. Monitor main output with oscilloscope.

   A. Using oscilloscope set to 1μsec per cm, check for approximately 1 cycle of square wave on screen.
   B. Set Multiplier to S-0 (against the stop) and set the oscilloscope Horizontal Sweep Speed for 1ms per cm. Adjust Search Sym A and Search Sym B for a time symmetrical Triangle wave that is slightly greater (approximately 2 millimeters) than 10cm.

5. Set Function to Triangle, Set Range to 1K, Set Multiplier to 1.0.

   A. Monitor tp456 using tp448 as a ground with the comparator oscilloscope. Adjust the Positive Peak Adjust for a positive triangle peak voltage of +.850V ± 1mv. Adjust the Negative Peak Adjust for a negative triangle peak voltage of -.850V ± 1mv.

6. Set Function to Square and monitor the main output of the generator with the frequency counter.

   A. Adjust the Frequency Adjust for a generator frequency of 1.000KHz. Check each range for timing accuracy from the .01Hz range to the 1MHz range. (It may be necessary to re-adjust the Frequency Adjustment so that all ranges fall within specifications.)
   B. Set Multiplier to 1.0 and range to 10M. Adjust the 10MHz adjust for a frequency of 10MHz ± 1%. This adjustment is on the range switch.

C. Set range to 1M. Adjust the 1MHz adjust for a frequency of 1MHz ± 1%.
D. Set range to 20M. Adjust the 20MHz adjust for a frequency of 20MHz.
E. Repeat steps B and C and D due to interaction.

7. Reset Function to Triangle and Reset Range to 1K, Multiplier to 1.0.

A. Connect oscilloscope to tp759 using tp824 as a ground. Adjust the Triangle D.C. Adjust for equal ± peaks ± 5mv.
B. Depress Fixed Offset and adjust the Offset Bal Adjust for a triangle starting at 0 volts ± 5mv.

8. Deactivate Offset and Neg. Connect oscilloscope to terminated main output.

A. Adjust PA Bal Adjust (D.C.) and the PA Gain Adjust for a triangle of 15.00V +20/-0mv peak to peak.
B. Switch Function to Square and adjust the Square Gain Adjust and the Square D.C. Adjust for a square wave of 15.00V ± 20/-0mv.
C. Switch Function to Sine and connect the harmonic distortion analyzer to the main output (terminated). Adjust the Sine Input Adjust and Sine A, Sine B, Sine C, and Sine D Adjusts for minimum Sine distortion.
D. Connect oscilloscope to main output (terminated) and Adjust the Sine Gain Adjust and Sine D.C. Adjust for an output of 15.00V +20/-0mv peak to peak.
E. Set Function to Square and Range to 10M. Adjust the Square Comp. Adjust for proper rise time, overshoot and sine rolloff.

9. Positive - Negative Lockout Bal. Set Function to normal triangle, Range to 1meg, Start Frequency to S-X, Run Pushbutton out (triggered), Gate/Trigger pushbutton out (triggered), Internal-External pushbutton out (external). Monitor main output with oscilloscope.

A. With oscilloscope set at 5ms/cm, set Phase control for approximately 0V D.C. level at output. Rotate vernier from S-X toward S-0 and adjust Negative Lockout Balance to obtain 0V D.C. level shift from S-X to S-0 on vernier dial.
B. Set Function to Inverted Triangle and adjust Positive Lockout Bal to obtain 0V D.C. shift from S-X to S-0 on vernier Multiplier Dial.

4.1.0 EQUIPMENT REQUIRED

This unit must be on for one hour with the covers in place and the output terminated into 50Ω before calibration.

The following equipment or suitable equivalents of known accuracy are required for complete calibration of the Model 7271.

Oscilloscope D.C. to 90MHz Differential input with 5mv/cm sensitivity.
Tektronix 7704 with 7A13 plug-in.

Counter-Timer 11 MHz to 10,000 seconds.
DANA 8010B or equivalent.

Digital Voltmeter .01% accuracy with 1000 megohm input impedance floating inputs.
DANA 4300

Harmonic Distortion Analyzer $<$ .1% Residual Distortion
Hewlett Packard 333.

1. INITIAL CONTROL SETTINGS

POWER SWITCH	On
START FREQUENCY	1.0
RANGE	1K
FUNCTION	Triangle
AMPLITUDE	Full clockwise
ATTENUATOR	Not activated (0db)
OFFSET	Not activated (Off)
RUN	Activated
INTERNAL	Deactivated
SWEEP ON	Deactivated
SWEEP GATED	Deactivated
SWEEP LOG	Deactivated
HOLD	Deactivated

2. Using DVM: (with tp120 as common) (Fig. 4.1.0)

A. Probe +24V measurement point (tp128) and adjust the +24V Adjust for +24.00V ± .01V.
B. Probe -24V measurement point (tp160) and adjust the -24V Adjust for -24.00V ± .01V.
C. Probe +15V measurement point (tp137) and adjust the +15V Adjust for +15.00V ± .01V.
D. Probe -15V measurement point (tp178) and adjust the -15V Adjust for -15.00V ± .01V.
E. Probe +3.2V measurement point (tp108) and adjust the +3.2V Adjust for +3.20V ± .01V.
F. Probe -2.0V measurement point (tp210) and check for -2.0V ± .20V.

SECTION 4

CALIBRATION PROCEDURE

MP MASTER
MA23393